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September 7, 2001

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Project: RAC Contract No. 68-W5-0022
Work Assignment No. 048-RICO-0801
DCN: 3282-948-RT-FEAS-12441
Subject: Replacement Pages for Final Focused Feasibility Study for Interim Water Treatment Operations - Operable Unit 2 (OU2), Gilt Edge Mine, Lawrence County, South Dakota

Dear Mr. Wangerud:

CDM Federal Programs Corporation (CDM Federal) is pleased to submit replacement pages for the Final Focused Feasibility Study (FFS) for Interim Water Treatment Operations, Operable Unit 2 (OU2), Gilt Edge Mine Site. Change out pages for this final document are the result of comments provided by South Dakota Department of Environment and Natural Resources and the discussions held during the water treatment operations meeting in Pierre, South Dakota on June 27 and 28, 2001. If you have any questions or comments regarding this SAP, please feel free to call me at (720) 264-1107.

Sincerely,

CDM FEDERAL PROGRAMS CORPORATION

Steven D. Fundingsland

Steven D. Fundingsland, P.G.
Project Manager

Attachment
cc: Project File/DCN - Denver
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Response Action Contract
For Remedial, Enforcement Oversight, and Non-Time Critical Removal Activities at Site of Release or Threatened Release Of Hazardous Substances in EPA Region VIII

U.S. EPA CONTRACT NO. 68-W5-0022

Final
Focused Feasibility Study
for
Gilt Edge Mine Site
Interim Water Treatment Operations
Operable Unit 2 (OU2)
Lawrence County, South Dakota

Work Assignment No.: 048-RICO-0801
Document Control No.: 3282-948-RT-FEAS-12441

Prepared for:

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August 2001

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Acronyms

µg/L	micrograms per liter
amsl	above mean sea level
ARARs	applicable or relevant and appropriate requirements
ARD	acid rock drainage
BOR	U.S. Bureau of Reclamation
$CaCO_3$	calcium carbonate
CaO	calcium oxide (quicklime)
CDM Federal	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CN-	cyanide anion
COC	contaminants of concern
COPC	chemicals of potential concern
DOC	U.S. Department of Commerce
EC	electrocoagulation
EPA	U.S. Environmental Protection Agency
ET	evapotranspiration
FEMA	Federal Emergency Management Agency
FFS	Focus Feasibility Study
FIRM	Flood Insurance Rate Map
gpm	gallons per minute
GRA	general response action
HCN	hydrogen cyanide
HDPE	high-density polyethylene
HLP	heap leach pad
IRAGs	interim remedial action goals
IRAOs	interim remedial action objectives
MCLs	maximum contaminant levels
MCSC	minimum cost to site closure
MF	microfiltration
mg/L	milligrams per liter
N/P	neutralization/precipitation
NaCN	sodium cyanide
NaOH	sodium hydroxide
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NF	nanofiltration
NOV	Notice of Violation
NPDES	National Pollutant Discharge Elimination System

NPL	National Priorities List
O&M	operations and maintenance
OED	South Dakota Office of Economic Development
PA	preliminary assessment
PMP	probable maximum precipitation
PQL	practical quantitation limit
RI/FS	Remedial Investigation/Feasibility Study
ROD	record of decision
SDDENR	South Dakota Department of Environment and Natural Resources
SI	site inspection
Site	Gilt Edge Mine Superfund Site
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
TSS	total suspended solids
UOS	URS Operating Services
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VLDPE	very low density polyethylene
WMC	Water Management Consultants
WTP	water treatment plant

Section 1
Introduction

1.1 Purpose

This Focused Feasibility Study (FFS) was prepared for the U.S. Environmental Protection Agency (EPA) Region VIII for Work Assignment No. 048-RICO-0801 under EPA Contract No. 68-W5-0022 by CDM Federal Programs Corporation (CDM Federal). This report addresses interim treatment of contaminated site waters originating from mining activities at the Gilt Edge Mine Superfund Site (the Site), located in Lawrence County, South Dakota. The purpose of the FFS is to provide a focused range of treatment alternatives for interim actions (Operable Unit 2) aimed towards final remedy, but not interfering with the final overall site remedy. The FFS was conducted to develop treatment alternatives for acid rock drainage (ARD). The water originates from sources altered or disturbed by mining activities at the Site.

All of the work performed in this FFS was conducted following guidance developed by EPA for conducting a FS under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA 1988). In addition, the cost estimates for each alternative were developed in accordance with *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA 2000a).

1.2 Organization

- Section 1 - Introduction, describes the site location, history, and environmental setting of the Site.

- Section 2 - Identification of Problem Statements, describes the nature and extent of impacts from past site activities to water leaving the Site.

- Section 3 - Development of Interim Remedial Action Objectives, describes the process for identifying interim remedial action objectives (IRAOs) and interim remedial action goals (IRAGs) (numerical standards) based on potential applicable or relevant and appropriate requirements (ARARs) and discusses the ecological risk assessment currently being performed by EPA that will effect final remedial action goals.

- Section 4 - Identification and Screening of General Response Actions, Technologies, and Process Options, describes the options for general response actions (GRAs), and the screening and evaluation of different technologies and process options.

- Section 5 - Development and Screening of Alternatives, describes the alternatives and the screening process followed to reduce the number of alternatives considered to be most suitable for implementation.

- Section 6 - Definition of Criteria Used in the Detailed Analysis of Retained Alternatives, describes the criteria used to evaluate the retained alternatives.

- Section 7 - Detailed Analysis of Retained Alternatives, presents a detailed analysis of the alternatives, and summarizes the comparative analysis conducted to determine the most appropriate remedial action.

- Section 8 - References, lists the documents referred to during the development of this FFS.

1.3 Site Location and Description

1.3.1 Site Location

The Site is located southeast of the Town of Lead in the northern Black Hills in Lawrence County, South Dakota (Figure 1-1). Specifically, the Site is in Sections 4, 5, 6, 7, 8, and 9, Township 4 North, Range 4 East of the Deadwood South Quadrangle, Lawrence County, South Dakota (U. S. Geological Survey [USGS] 1971). Site coordinates are 44° 19' 43" north latitude and 103° 44' 28" west longitude.

1.3.2 Site Description

The area has been mined intermittently by several owners, from the late 1800s to the present. Cyanide leaching, mercury amalgamation, and zinc precipitation among other methods were used to recover gold. The Gilt Edge Mine is currently owned by the Brohm Mining Corporation (Brohm). Brohm was issued a permit by the South Dakota Department of Environmental and Natural Resources (SDDENR) for open pit/heap leach operations. The operation was permitted to affect approximately 406 acres. The Gilt Edge Mine currently consists of a heap leach pad in addition to several ore extraction pits. The heap leach pad covers 37 acres with approximately 3.2 million tons of spent ore. An expansion to this pad was started with grubbing and liner placement; however, no ore was processed on the expansion pad. A second heap leach pad covering 19 acres was planned for Phase II of the Anchor Hill Pit. The processing area consists of a single on-off load leach pad with an asphalt primary liner and a high density polyethylene (HDPE) and soil composite secondary liner. The heap leach pad was retrofitted in 1989 with a very low density polyethylene (VLDPE) liner to improve the integrity of the primary liner. There are also surge, neutralization, and diatomaceous earth ponds, with HDPE primary liners and HDPE and soil composite secondary liners (URS Operating Services [UOS] 1999).

Ore for the Gilt Edge Pad was obtained from the Dakota Maid/Sunday Pits (17 and 29.5 acres), the SE Langley Pit (8.1 acres), and Phase I of the Anchor Hill Pit (23.6 acres) (UOS 1999). Waste rock from the mining activities and spent ore from the heap leach pad were transported to the Ruby Waste Dump, a tiered storage area for processed waste rock in the Ruby Gulch drainage. The Ruby Waste Dump is part of the Gilt Edge mining process and is recognized as the main source of ARD in the Gilt Edge mining operations (UOS 1999).

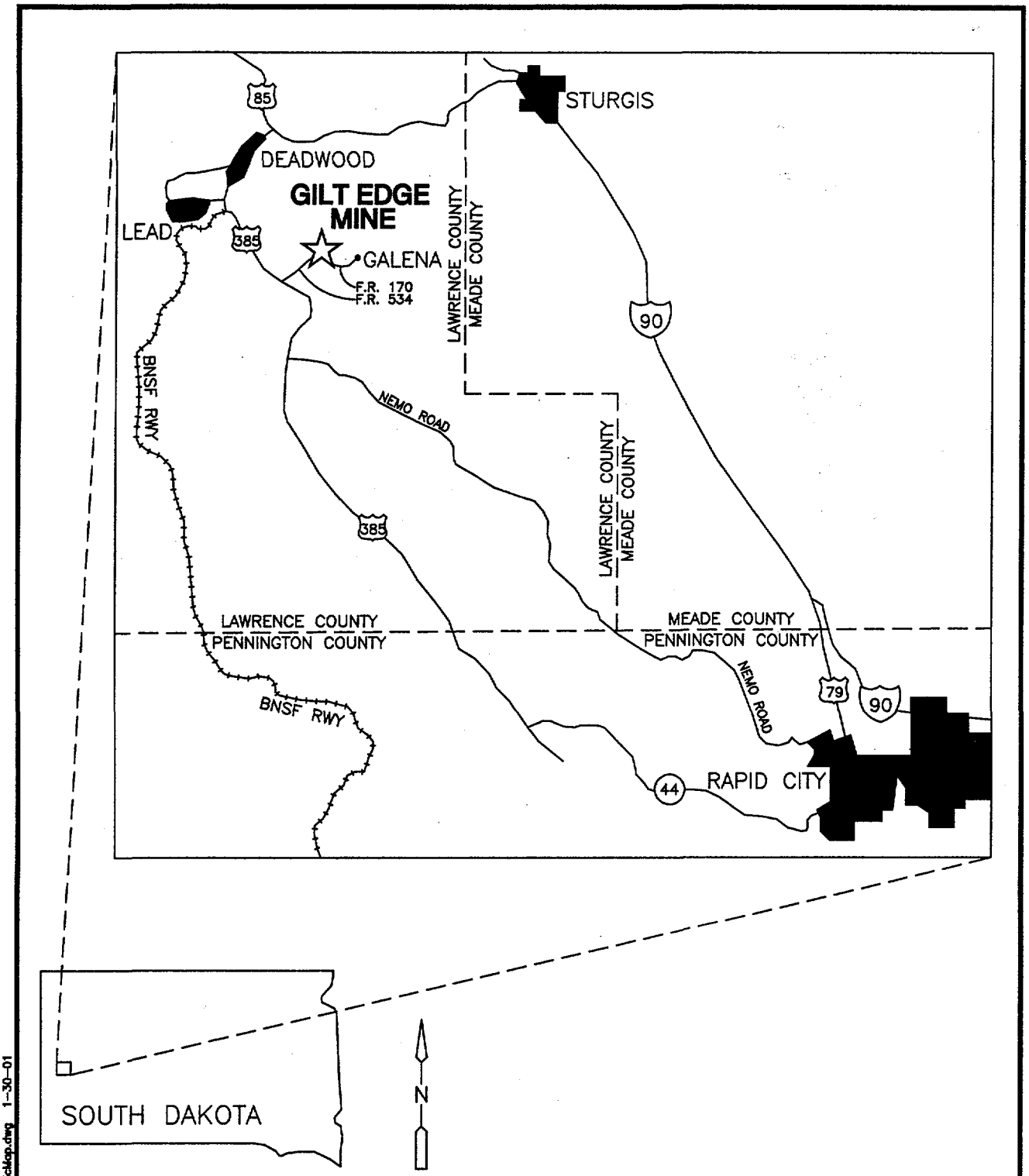

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FIGURE 1-1

SITE LOCATION MAP

GILT EDGE MINE SITE
LAWRENCE COUNTY, SOUTH DAKOTA

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A containment pond for the Ruby Waste Dump is used to capture the ARD from the dump. This containment pond was built within the Ruby Gulch drainage below the waste rock repository. The ARD that drains from the Ruby Waste Dump is collected in the containment pond and then pumped to the Dakota Maid/Sunday Pit from the Ruby Pond Pumphouse. The ARD is then pumped and/or siphoned to Pond E near Strawberry Creek. From Pond E, ARD is pumped to a water treatment plant where it is treated and released into the Strawberry Creek drainage. The pump station at Pond E (Strawberry Pond Pumphouse) can also direct flow to turbomisters for evaporation or pump flow back to the Dakota Maid/Sunday Pit. ARD from the Anchor Hill Pit and Langley Pit is also pumped to the Dakota Maid/Sunday Pit (Figure 1-2) where it follows the same flow path to the water treatment plant for treatment. Site water conveyance piping and pump stations are shown on Figure 1-3. In April 1998, an estimated 136,000,000 gallons of ARD waters were awaiting treatment at the Site. As of February 2001, the Sunday Pit contains about 37,500,000 gallons of ARD water, the Dakota Maid Pit contains an estimated 1,000,000 gallons of ARD water, and Anchor Hill Pit contains about 69,000,000 gallons of ARD water that require treatment.

The water treatment plant is located near the top of Ruby Gulch. It is a sodium hydroxide neutralization/precipitation (N/P) plant consisting of a 360-gallon upflow rapid mix tank where 50 percent solution sodium hydroxide is mixed with influent ARD and recycled metal precipitate sludge from the clarifier. A vertical shaft propeller mixer provides tank mixing. Following the rapid mix tank, the ARD/sodium hydroxide solution flows to a 1,100-gallon flocculation tank that precedes a 10,000-gallon lamella plate clarifier. Polymer is added to the flow just prior to entering the flocculation tank. Effluent from the clarifier flows to a 5,000-gallon effluent storage tank and is subsequently discharged by gravity flow/pumped flow to Strawberry Creek. Anticipated optimization of the current process train by the Bureau of Reclamation (BOR) will include a higher sludge return rate (~20 to 30 percent of influent flow) from the lamella plate clarifier to the rapid mix tank, while the remainder of the sludge is discharged to an onsite stormwater collection pond. Additional improvements may also include the use of a filter press to treat the sludge flow that is discharged to the collection pond. The water treatment plant has a reported design capacity of 360 gallons per minute (gpm) (BOR 2000) but is currently operating at a reduced capacity of 250 gpm in order to meet the former National Pollution Discharge Elimination System (NPDES) discharge limits. Approximately 200 gpm of treated ARD is discharged to Strawberry Creek. A plan view process flow diagram of the water treatment plant (WTP) is shown on Figure 1-4.

ANCHOR HILL PERMIT BOUNDARY

PERMIT #439 BOUNDARY

Anchor Hill Pit

Stormwater Pond

Heap Leach Pad

Ruby Gulch Waste Rock Dump

DE Pond

Process Plant

Surge Pond

Neutralization Pond

Ruby Pond

Ruby Pond Pumphouse

Ruby Gulch

Crusher Area

Water Treatment Plant

Dakota Maid Pit

Pond C

Sunday Pit

Pond D

Main Office

HooDoo Gulch

Terrible Gulch

Pond E

Strawberry Pond Pumphouse

Cabin Creek

Langley Pit

Strawberry Creek

Bear Butte Creek

LEGEND

- Anchor Hill Permit Boundary
- Permit 439 Boundary
- Creek or Stream
- Topographic Contour, 5-foot Interval
- Improved Gravel Road
- Unmaintained Road
- Building or Tank
- Lake or Pond

N

200 0 200 400 Feet

CDM Federal Programs Corporation

FIGURE 1-2

SITE FEATURES AND BOUNDARIES

GILT EDGE MINE
LAWRENCE COUNTY, SOUTH DAKOTA

05-11-01 m:\3280-rac\81048-gilted\gis\siswstdy1.apr SiteMapPermitBnd

Anchor Hill Pit
Stormwater Pond
Heap Leach Pad
Ruby Gulch Waste Rock Dump
DE Pond
Process Plant
Surge Pond
Neutralization Pond
Ruby Pond
Ruby Pond Pumphouse
Ruby Gulch
Crusher Area
Water Treatment Plant
Pond C
Dakota Maid Pit
Sunday Pit
Pond D
Main Office
HooDoo Gulch
Terrible Gulch
Pond E
Strawberry Pond Pumphouse
Cabin Creek
Langley Pit
Strawberry Creek
Bear Butte Creek

LEGEND

- Portable Water Conveyance Pump
- Water Conveyance Pipe
- Creek or Stream
- Topographic Contour, 5-foot Interval
- Improved Gravel Road
- Unmaintained Road
- Building or Tank
- Lake or Pond

N

200 0 200 400 Feet

CDM Federal Programs Corporation

FIGURE 1-3

SITE WATER CONVEYANCE PIPING AND PUMP STATIONS

GILT EDGE MINE
LAWRENCE COUNTY, SOUTH DAKOTA

6-07-01 m:\3260-rac6\046-gilledge\gis\swsty1.apr PipeAndPumpStations

Sludge to Waste

Route Sludge to New Belt Filter Press for Landfill Disposal and/or Sludge Discharge to Stormwater Pond

Sludge Discharge to Stormwater Pond

Direct Discharge from Clarifier to Strawberry Creek if Effluent meets requirements

Temporary Addition of Ferric Chloride

Effluent

Sludge Discharge to Sunday Pit

Sludge Pump

Polymer Dilution System and Storage Tank

Polymer Feed Pump

Effluent Storage Tank

Effluent Pump

Former Sludge Storage Tank
18' ϕ, 18'-2" h
10,000 gallons

Reaction Tank

Overflow

Influent

Lab Table

Belt Filter Press

Inclined Plate Clarifier
12'ϕ , 17' h
14,400 gallons

Former Ferric Chloride Storage Tank

Overflow Effluent Storage Tank
6,400 gallons

Reaction Tank Transfer Pump

Sludge Recycle

Polymer Feed Line

Flocculation Tank
8'ϕ, 3' h
1,127 gallons

Sodium Hydroxide
50% Solution
Storage Tank

Rapid Mix Tank
10'ϕ,16' h
9,400 gallons

NaOH Feed Pump

LEGEND

Existing WTP Process

BOR Modifications to WTP (assumed to be the basis for the interim water treatment FFS)

CDM Federal Programs Corporation
A Subsidiary of Camp Dresser & McKee Inc.

FIGURE 1-4

EXISTING ARD TREATMENT PLANT PROCESS PLAN VIEW

GILT EDGE MINE
LAWRENCE COUNTY, SOUTH DAKOTA

V:\mustard\projects\gilt edge\existing plant.cdr 5/29/01

1.4 Site History of Water Treatment

In 1986, SDDENR issued South Dakota Mining Permit No. 439 to Brohm for the open pit/heap leach operations (UOS 1999). The permit contained several conditions that addressed the tailings and the potential for ARD. One condition required Brohm to remove some of the tailings from Strawberry Creek. These tailings were to be used as bed liner for the leach pad. Another condition of the permit required Brohm to install a pump back system designed to prevent acid discharges from the mine workings from entering Strawberry and Bear Butte Creeks. Construction of the open-pit mine and cyanide heap leaching facilities was initiated in August 1987. Mining of the Dakota Maid and Sunday Pits was completed in 1992. In 1991, cyanide leaked from the cyanide heap leach pad into Strawberry Creek and Bear Butte Creek. Unpermitted discharges of acid water, aluminum, cadmium, copper, lead, and zinc from two areas were identified by EPA during an inspection in 1992 under the NPDES. In 1993, EPA issued a NPDES surface water discharge permit to Brohm. Two NPDES compliance points were designated including one in Strawberry Creek, and one in Ruby Gulch, an intermittent tributary to Bear Butte Creek. NPDES permit violations based on low pH and dissolved metal levels in excess of permitted concentrations have occurred on several occasions since the permit was issued. ARD from the Ruby Waste Rock Dump was first detected in 1993.

On May 21, 1998, Brohm reported that it would abandon the Site, and subsequently stopped mining activities on May 29, 1998. The State of South Dakota secured an injunction to prevent the removal of equipment from the Site. Brohm's parent company, Dakota Mining Corporation, filed for bankruptcy in Canada in 1999. The Site was proposed for inclusion on the National Priorities List (NPL) on May 11, 2000. The Site was placed on the NPL on December 1, 2000.

The mine is currently inactive with the exception of EPA Region VIII Emergency Response contractor working on the Ruby Gulch Waste Rock Dump cap, workers who operate the water treatment system, and technical and administrative personnel from the BOR who are responsible for overall site control including site access, security, maintenance, and construction activities.

1.5 Previous Investigations

Water quality has been monitored at the mine site from 1985 to the present. Hydro Engineering Consultants presented data from 1985 through 1993 in a report titled Ground-Water Hydrology at Brohm's Gilt Edge Mine, dated March 1994 (BOR 2000).

A preliminary assessment (PA) of the Site was prepared in 1991 by the DENR. An evaluation of the biological community of Strawberry Creek was conducted in 1996.

UOS prepared the site inspection (SI) for the Site in 1999. Soil, sediment, and surface water samples were collected and analyzed for heavy metals and cyanide during the

SI. UOS also collected surface water and groundwater samples in June and September 2000 as part of the Gilt Edge Mine Site Investigation.

Robertson GeoConsultants, Inc. (Robertson) prepared a geochemical field reconnaissance survey of the Site in 2000. The survey was conducted to classify the acid potential of the materials remaining on the Site from recent mine activities.

1.6 Environmental Setting

1.6.1 Surface Features

The Site is located in the Black Hills of South Dakota, immediately adjacent to the upper reaches of Strawberry Creek. The Black Hills are characterized by mountainous topography with highly eroded outcrops and broad valleys. The elevation of the mining district ranges from approximately 5,320 to 5,520 feet above mean sea level (amsl) (UOS 1999).

Located in the south half of Section 5 in Township 4 North, Range 4 East, the original topography of the Site prior to placing the waste rock shows the head of Ruby Gulch to have a south fork and a north fork. Ruby Gulch is a moderately steep mountain stream with an estimated gradient of 0.074. The gulch is described as ephemeral in its upper reaches and intermittent in the middle and lower reaches. The dump foundation surface was cleared of vegetation, and topsoil was removed and stockpiled for future use at the Site. Foundation conditions were generally dry; however, there were some exceptions. Investigations reported subsurface groundwater flow in upper Ruby Gulch with surface flow appearing where the gulch crosses the boundary with Section 4 of Township 4 North, Range 4 East. Ice was also observed in Ruby Gulch as high as the 5,400-foot elevation contour in the south fork and a small seep (<0.5 gpm) found a few feet above the drainage bottom on the north side, at the 4,920-foot elevation contour.

The dump was constructed by end dumping rock in layers up to 50 feet thick. Large boulders (up to 10 feet in diameter) are present in the dump. Compaction was achieved by routing haul equipment over the dump. The placing method by end dumping has resulted in the accumulation of large boulders at the base of the lifts creating a French drain effect in the lower portions of the dump. The dump is considered to be very porous and permeable. The dump contains an estimated 20 million tons of waste rock occupying a volume of approximately 12 million cubic yards. The upper portion of the dump contains slopes at various angles of repose.

Drainage ditches have been placed on the sides of the dump and the main dump slope has been graded to a smooth surface that contains several benches that stair-step down the gulch. The drainage ditches are in poor condition. A HDPE-lined collection pond (Ruby Collection Pond) and a pumping facility have been placed at the base of the dump to collect ARD and return it to the Site for treatment.

1.6.2 Geology

A description of the area geology including regional setting, stratigraphy, mineralogy, soils, and hydrogeology is presented in Gilt Edge Mine Background Report (CDM Federal 2001).

1.6.3 Site Hydrology

1.6.3.1 Major Drainage Basins

The surface water at the Site drains through three subbasins into Bear Butte Creek. The subbasins are Strawberry Creek drainage, Hoodoo Gulch, and Ruby Gulch, and are 0.39, 0.05, and 0.07 square miles in area, respectively. The topography is characterized by mountainous terrain with narrow valleys. Anchor Hill forms the highest point on the north side of the Site area at an elevation of 5,680 feet amsl. An unnamed peak on the east side of the Site area is at elevation 5,650 feet amsl. The lowest point is at approximately 4,880 feet amsl at the confluence of Bear Butte and Ruby Gulch. The mountain slopes range from 6 to 60 percent and the soil permeability is classified as moderate, averaging about 4 inches per hour (BOR 2000).

The current operations control runoff from the mined areas by various means. The primary ARD generating area is the Ruby waste rock repository at the head of the Ruby Gulch. ARD flow from the repository is collected in a containment pond and then pumped back to the Sunday Pit. A minor amount of water seeps from the Sunday Pit to the Dakota Maid Pit. From there, water is siphoned/pumped to Pond E. Some ARD drains from Dakota Maid Pit into Pond D near the former location of the Joe King Adit. Pond D drains into Pond E. Pond E is lined with a HDPE liner. From Pond E, the ARD can be sent to the water treatment plant, the turbomisters, or back to the Dakota Maid Pit (UOS 1999).

Topography directs surface water flow from the Gilt Edge Mine Site to Strawberry Creek. Strawberry Creek flows approximately 1.5 miles before draining into Bear Butte Creek. Approximately 2 miles downstream of the Strawberry Creek and Bear Butte confluence, Bear Butte Creek becomes a losing stream that flows into outcrops of the Pahasapa limestone (UOS 1999).

The USGS maintains a gauging station in Bear Butte Creek 0.5 miles downstream of the Bear Butte/Strawberry Creek confluence. Water discharge data from October 1996 to September 1997 indicates that Bear Butte Creek's high flow is in April with more than 100 cubic feet per second (cfs) for 5 days and a 1-day maximum of 180 cfs. By June, the flow has fallen to less than 10 cfs. March, April, May, and June gauging data show flows over 10 cfs in Bear Butte Creek, with all other months having flows under 10 cfs. It is possible that Strawberry Creek could approach 10 cfs under high water flow conditions, but for the majority of the year, the flow in Strawberry Creek is well under 10 cfs (UOS 1999).

The PA indicates that the Site is not located within a floodplain. Information obtained from a Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) indicates that Strawberry Creek, Boomer Gulch, and Butcher Gulch are located within 500-year floodplains. However, at their confluence with Bear Butte Creek, these drainages lie within the 100-year floodplain, as does the remainder of Bear Butte Creek (UOS 1999).

1.6.3.2 Former NPDES Discharge Monitoring

Brohm Mining Corporation acquired a NPDES permit containing both discharge limits and monitoring requirements for surface water discharges. Brohm's NPDES permit was terminated by SDDENR when Brohm abandoned the Site. The former compliance points are located in Strawberry Creek (001 - 10 yards downstream of Strawberry Creek's confluence with Boomer Gulch) and Ruby Gulch (002/003 - below the final sedimentation pond). The former NPDES limits based on a water hardness of 400 milligrams per liter (mg/L) as calcium carbonate ($CaCO_3$) are included in Table 1-1 (EPA 1993).

1.6.4 Climate

According to the Great Plains International Data Network Mean minimum and maximum temperatures in January and July are 5 and 33 degrees Fahrenheit (°F), and 55 and 80°F, respectively. The mean number of freeze-free days is 150 (U. S. Department of Commerce [DOC] 1968). Prevailing winds are out of the northwest at approximately 10 to 13 miles per hour (DOC 1968).

Mean annual precipitation in the Black Hills area ranges from 19 to 24 inches. Precipitation is higher at the Site ranging from 25 to 30 inches per year. Mean annual snowfall is approximately 60 to 100 inches per year (DOC 1968). The design storm events for the Site were estimated upwards by the mine consultants Steffen, Robertson, and Kirsten to be 9.47 inches for the 100-year, 24-hour event, 5.87 inches for the 25-year, 24-hour event, and 4.28 inches for the 10-year, 24-hour event (Water Management Consultants [WMC] 1999). The probable maximum precipitation (PMP) event has been estimated to be a 6-hour storm event of 19.6 inches based on rainfall during the flood of 1972 (correspondence with SDDENR). Average annual pan evaporation at the nearby Golden Reward Mine is approximately 19 inches (WMC 1999). However, measurable evapotranspiration (ET) generally only occurs during early summer to early fall (May through October).

1.6.5 Demographics and Land Use

This description of demographics and land use were taken from a web page maintained by the South Dakota Governor's Office of Economic Development (OED) in October 2000.

Table 1-1 Former NPDES Permit Limits

Parameter	Daily Maximum		24-Hour[B]	30-Day	Units
	001A	002/003	001	Average	
Total Recoverable Arsenic	0.3325	NE	0.19	NE	mg/L
Total Recoverable Cadmium	0.0059	0.1	0.0034	NE	mg/L
Total Recoverable Chromium	1.147	NE	0.655	NE	mg/L
Total Recoverable Copper	0.0676	0.3	0.039	0.15	mg/L
Total Recoverable Lead	0.0325	0.6	0.0186	0.30	mg/L
Total Recoverable Mercury	2.1E-5[C]	0.002	1.2E-5[C]	0.001	mg/L
Total Recoverable Nickel	0.891	NE	0.509	NE	mg/L
Total Recoverable Selenium	0.00875	0.00875	0.005	NE	mg/L
Total Recoverable Silver	0.044	NE	0.044	NE	mg/L
Total Recoverable Zinc	0.343	1.5	0.343	0.75	mg/L
Total Cyanide	0.02	0.07	NE	NE	mg/L
TPH	10	10	NE	NE	mg/L
TSS[D]	157.5	30	NE	90[F]/20[G]	mg/L
Settleable Solids[E]	NE	0.5	NE	NE	mg/L
pH	6.5 to 8.8	6 to 9	NE	NE	Standard Units

TPH Total petroleum hydrocarbons.
NA Not applicable.
NE Not established.
TSS Total suspended solids.
A Standards apply when a grab sample is collected.
B Applicable only for a 24-hour composite sample.
C The standard for mercury is less than the current approved analytical method for determining mercury concentration. Therefore, a practical quantitation limit (PQL) has been established for mercury at 1.0 micrograms per liter (µg/L). Analytical values less than 1.0 µg/L should be recorded as such.
D Dry weather.
E Wet weather.
F Established for compliance point 001.
G Established for compliance point 002/003.

The population of Lawrence County in 1998 was 22,508. Approximately 10,090 people are included in the labor force with an unemployment rate of 2.5 percent. The major types of employers in Lawrence County include hospitality (gaming), gold mining, education, health care, and local and county government.

Land use varies in Lawrence County. It includes recreational use (including U.S. Department of Agriculture (USDA) Forest Service areas and National Park Service areas), mining, urban and residential use, agricultural use, and light industrial use. Land use in the immediate area of the Site is primarily for mining and recreational purposes (USDA Forest Service land).

1.6.6 Current and Potential Future Site and Resource Uses

The Site is currently an inactive hard rock mine. Mining is conducted in the surrounding metamorphic areas of the Black Hills. Other potential uses for the

surrounding area include recreation, hunting, timber production, and woodland grazing. The Site is not easily accessible from the wilderness areas surrounding the mine. There is no resident population on or within 1/2-mile of the mine site.

Section 2
Identification of Problem Statements

2.1 Sources of Contamination

2.1.1 Acid Rock Drainage

The chemical ingredients needed to produce ARD are oxygen, water, and sulfide minerals. Sulfide mineral oxidation by water derived from snowmelt and rainfall is a normal geologic process; however, it is markedly accelerated by increased exposure of sulfide minerals to water and oxygen as a result of manmade excavations in sulfide bearing rock formations. Catalyzation of reactions by indigenous bacteria, *Thiobacillas ferrooxidans (T. ferrooxidans),* often accompanies and accelerates the reactions. Pyrite and other sulfide minerals undergo weathering and produce acid solutions containing sulfate ions along with iron, copper, and other dissolved metals. These acid solutions can have a pH of less than 4.0 and can cause significant degradation of water quality (low pH and high dissolved metals concentrations).

The initial result of pyrite reaction with oxygen and water is represented in the following equation:

$$FeS_2 + 7/2\ O_2 + H_2O \rightarrow Fe^{2+} + 2\ SO_4^{2-} + 2H^+ \quad (1)$$

At a pH above 2.5, ferrous iron (Fe^{2+}) will precipitate as a hydroxide:

$$Fe^{2+} + 5/2\ H_2O + 1/2\ O_2 \rightarrow Fe(OH)_3 + 2H^+ \quad (2)$$

At a pH below 2.5, a cycle is established in which Fe^{2+} is oxidized by oxygen to ferric iron (Fe^{3+}), which is subsequently reduced by pyrite, thereby generating additional Fe^{2+} and acidity. The reduction of Fe^{3+} by pyrite occurs both in the presence and absence of oxygen (Singer, Stumm 1969). This sequence can be represented as:

$$Fe^{2+} + 1/4\ O_2 + H^+ \xrightarrow{T.\ ferrooxidans} Fe^{3+} + 1/2\ H_2O \quad (3)$$

$$FeS_2 + 14\ Fe^{3+} + 8\ H_2O \rightarrow 15\ Fe^{2+} + 2\ SO_4^{2-} + 16\ H^+ \quad (4)$$

Oxidation of ferrous iron to ferric iron (eq. 3) is a slow reaction unless it is catalyzed by bacteria. Once oxidized however, the subsequent reduction reaction (eq. 4) proceeds rapidly. Oxidation of sulfide minerals will continue until all sulfide supply has been depleted.

At Gilt Edge, mining activities resulted in additional sulfidic material surface area available for contact with oxygen and water. Air and water contact with the additional surface area provided by broken rock accelerates oxidation of minerals and creation of low pH drainage. This drainage water is high in acidity, sulfate (SO_4^{2-}) ions, and dissolved metals. Additionally, the high levels of dissolved metals and sulfate ions contribute to an overall high level of total dissolved solids (TDS) in the drainage water.

ARD water contributes metal and TDS loads to Strawberry Creek and Bear Butte Creek. This creates adverse conditions preventing the growth and maintenance of a healthy aquatic ecosystem. These adverse effects have been noted in various studies of water quality of Strawberry Creek and the Bear Butte Creek.

2.1.2 Water Containing Cyanide

Commercially manufactured sodium cyanide (NaCN) was used at the Site for extracting precious metals from ore grade materials. Cyanide has been used for this purpose in the mining industry since the late 1800s. Cyanide is found either in simple form or in combination with other elements. Simple cyanide forms designated as "free" cyanide are the cyanide anion (CN-) and hydrogen cyanide (HCN). Cyanide also combines or complexes with alkali metal ions, heavy metal ions, and transition elements. The complex cyanide bonding is very strong, moderately strong, or weak (defined by tendency to disassociate in an acidic environment). Presence of excess hydrogen ions (acid) will lead to the formation of HCN, depending on the strength of the metal/cyanide bond.

The Heap Leach Pad has been rinsed and detoxified to eliminate cyanide. Cyanide (weak acid dissociable) content is below 0.01 mg/L (the laboratory detection limit for samples taken from July 27, 1993 through February 15, 2000) in the drainage water stored in Sunday Pit that is subsequently treated at the water treatment plant. Residual process water contained in the Heap Leach Pad contains nitrate, nitrite, sulfate, selenium, and other dissolved metals and will require treatment before discharge.

2.2 Summary of Nature and Extent of Contamination

A remedial investigation has not been completed for this Site or operable unit. However, known sources of contamination have been documented. Known sources of contamination associated with Strawberry Creek include the Heap Leach Pad; Sunday, Dakota Maid, and Anchor Hill Pits; and relic tailings formerly in Strawberry Creek. ARD from Ruby Waste Rock Dump is a source of contamination for the Ruby Gulch drainage where it joins Bear Butte Creek. A system designed to contain and treat ARD throughout the Site is currently in place and operating; however, several discharges and violations of permit limits have occurred on Strawberry Creek and Ruby Gulch.

Other discharges from site sources are summarized below:

- Water in the Dakota Maid Pit discharges at a seep in the east side of Strawberry Creek through underground workings left by historical mining activities (EPA 2000b).

- As part of the evaluation of pollutant loading in Strawberry Creek required by the Findings of Violation and Order for compliance issued by EPA on November 24, 1992, Brohm discovered a seep between sedimentation ponds D and E that drained

into Strawberry Creek. This seep may be affecting the water quality of Strawberry Creek (EPA 2000b).

- Overflow from several sediment ponds constructed at the Site may empty into the Strawberry Creek culvert during runoff periods (EPA 2000b).

2.3 Contaminant Transport and Migration

2.3.1 Surface Water

Surface water is considered the most significant media for offsite transport of contaminants. Surface water has been impacted by mining operations from the Site throughout the reach of Strawberry Creek from the Site to Bear Butte Creek and within Bear Butte Creek from Strawberry Creek to Galena and points further downstream.

2.3.2 Groundwater

Transport and migration of contaminants offsite through the Site alluvial and bedrock groundwater systems is unknown and will be investigated during the overall site remedial investigation. Groundwater that comes into contact with sulfide bearing rock materials in the underground mine workings and open pits also has the potential to create ARD.

With current Site conditions, it is assumed that nearly all ARD associated with groundwater sources would be contained in the open pits onsite and be mixed with the ARD created by surface water. Therefore, transport and migration of contaminants would still be through surface water discharge from the Site.

2.4 Site Risks

Without the water collection and treatment, contaminant sources at the Gilt Edge Mine are uncontained with respect to the surface water pathway and are free to release from the Site down the Strawberry Creek and Ruby Creek drainages. Both the Strawberry and Ruby Creek drainages contribute to Bear Butte Creek.

2.4.1 Human Health Risks

Untreated surface water contained at the Site exhibits low pH, and contains elevated metal and sulfate concentrations. Therefore, this water could adversely affect human health if contacted or ingested.

Water with low pH can irritate the skin or have the same dermal effects as a mildly acidic reagent. Site safety and health regulations require the use of protective clothing and equipment to minimize direct worker contact with water containing metals, cyanide, or exhibiting low pH. Standards for dermal exposures to high concentrations of metals in surface water do not exist.

Maximum contaminant levels (MCLs) are standards that are applicable to drinking water supplies. The federal and state drinking water MCLs provide dissolved concentration limits for cadmium (0.005 mg/L), copper (1.3 mg/L), lead (0.015), nitrate (10 mg/L), and thallium (0.002). Water draining from the Site without treatment exceeds all of these standards. *ARD impacted water from the Gilt Edge Mining area discharges to Strawberry Creek, which is a major tributary to Bear Butte Creek. Bear Butte Creek, during normal flow periods, loses all of its discharge to sinkholes in the Madison aquifer. The capture zones of the Boulder Canyon Development wells, the City of Sturgis well, and a Veterans Administration well, which draw water from the Madison formation, all appear to include the sinkhole region of Bear Butte Creek. Thus a pathway exists from the Gilt Edge Mine to the City of Sturgis well and other nearby water supply wells.*

ARD from Gilt Edge Mine historically has been shown to result in elevated concentrations of metals in Bear Butte Creek. Prior to the water treatment initiated at Gilt Edge Mine, ARD discharge to Strawberry Creek was responsible for approximately 40 percent to 80 percent of the metals loading in Bear Butte Creek. Dilution by uncontaminated inflows to Bear Butte Creek reduced metal concentrations, but some metals nevertheless periodically exceeded water quality standards. Thus, if Gilt Edge Mine waters are allowed to discharge untreated as in the past, adverse impacts to water quality may result at down gradient locations in the Madison formation.

If ARD impacted water in Bear Butte Creek discharges to and travels in the Madison limestone, metal concentrations are likely to be reduced due to reaction with the limestone. However, a series of bench-scale tests designed to simulate mixing of Bear Butte Creek water and Madison water in the Madison aquifer indicate that 'break through' of some metals, particularly arsenic and manganese, may still occur. The column tests showed that metals such as copper, iron, and zinc were effectively "treated" by the Madison limestone, but arsenic and manganese broke through. These tests were conducted with pulverized limestone, whereas the Madison formation is characterized by solution features such as caves. Consequently, groundwater travels at relatively fast rates with less potential for reaction with the surrounding rock. For example, a dye tracer study in an adjacent drainage indicated groundwater flows in the Madison formation at rates of 0.2 miles/day or greater. With such fast flow rates, water-rock interactions may not be sufficient to mitigate water quality problems prior to uptake by water supply wells (Dawson EPA 2001). An interim response action is required to provide continued containment and treatment of site surface water to protect the public health from releases of hazardous substances.

2.4.2 Environmental Risks

2.4.2.1 Documented Impacts

Impacts to aquatic life from contaminant transport and migration offsite have been documented in both Strawberry and Bear Butte Creeks. In Strawberry Creek, there have been documented impacts to the benthic macroinvertebrate communities.

The SDDENR conducted fish tissue sampling in Bear Butte Creek in September 1997. Fish tissue from longnose dace, white sucker, mountain sucker, and brook trout were analyzed. Metals were detected in all of the fish filet samples.

Bear Butte Creek is managed as a fishery by the South Dakota Game Fish and Parks Department. The fishery has been described as marginal, with little use. A 23-day creek survey conducted in 1994 by South Dakota Game Fish and Parks Department revealed no fish caught during the survey. However, Bear Butte Creek was stocked with brook, brown, and rainbow trout through the 1980s and with brown trout through the 1990s.

2.4.2.2 Stream Use Classifications and Numerical Standards

All streams in South Dakota are assigned the beneficial uses of irrigation, fish and wildlife propagation, recreation, and stock watering. Specifically, Strawberry Creek has been designated as cold water marginal fish life propagation waters and Bear Butte Creek directly above and below the Strawberry Creek confluence (down to approximate location of the sinkhole area) is a coldwater permanent fishery. The State of South Dakota Surface Water Quality Requirements set forth surface water quality standards for toxic pollutants for aquatic life. These standards are shown in Appendix A (Identification and Description of Applicable or Relevant and Appropriate Requirements, Gilt Edge Mine Site Water Treatment Plant, May 2001). Water draining from the Site without treatment exceeds all of these standards except the standard for cyanide. An interim response action is necessary to provide for continued containment and treatment of Site surface water in order to protect the environment from releases of hazardous substances.

2.5 EPA Actions at Gilt Edge

Brohm Mining Company ceased financial support of the Site in June 1999. Operation of water treatment facilities was taken over by the SDDENR. At the request of the Governor of South Dakota, EPA proposed the Site for the Superfund National Priorities List on May 11, 2000. In August of 2000, operation of the water treatment facilities was taken over by EPA Region VIII, Emergency Response Branch. This action was also at the request of the Governor of South Dakota and SDDENR. The following summarizes the history of documented releases of hazardous substances into surface water and enforcement actions at the Site.

December 1939 through September 1941 - Mine tailings were discharged down Strawberry Creek and into Bear Butte Creek. When the mine closed in 1941, piles of acidic tailings were left along Strawberry Creek. These tailings continually discharged acid and metal-laden water into the creek, until they were removed by Brohm Mining Corporation (BOR 2000).

June 20-21, 1991 - Cyanide leaked from the cyanide heap leach pad and was released into Strawberry Creek and Bear Butte Creek. Sodium cyanide was used in the heap

leach process to extract gold from crushed ore (EPA 2000b). The SDDENR issued Brohm a Notice of Violation (NOV) and Order and received a penalty of $99,800.

1991 - A Preliminary Assessment of the Gilt Edge Mine Site was prepared in 1991 by the SDDENR.

May 19, 1992 - EPA conducted an NPDES Inspection and found that two areas were discharging without a permit: (1) water seeping from the toe of Ruby Repository, and (2) pollutants from several point sources entering the Strawberry Creek diversion culvert through sedimentation ponds. The pH of the water from the toe of Ruby Repository was low and contained the following pollutants: aluminum, cadmium, copper, lead, and zinc; the pH of water discharged to Strawberry Creek was also low and contained the following pollutants: ARD, aluminum, cadmium, copper, iron, lead, and zinc (EPA 2000b).

August 10, 1992 - EPA transmitted an inspection report to Brohm requiring application for a NPDES permit (EPA 2000b).

November 24, 1992 - EPA issued Findings of Violation and Order for Compliance setting forth monitoring requirements and interim performance standards for Strawberry Creek and Ruby Gulch (EPA 2000b).

April 19, 1993 - SDDENR issued a Notice of Violation based on low pH and concentrations of sulfate, aluminum, copper, iron, manganese, and zinc in the Ruby Gulch discharge (EPA 2000b).

September 14, 1993 - EPA executed an Order for Compliance on Consent, which superceded the November 24, 1992, order (EPA 2000b).

September 15, 1993 - EPA issued NPDES permit Number SD-0026891 to Brohm (EPA 2000b).

February 15, 1994 - SDDENR issued a letter regarding NPDES permit violations at Compliance Point 002 in Ruby Gulch (for pH, cadmium, copper, and zinc) in February 1994 (EPA 2000b).

March 31, 1994 - EPA issued a Notice of Proposed Assessment of Class II Civil Penalty on NPDES permit Number SD-0026891 (EPA 2000b).

August 25, 1994 - EPA issued a Consent Order based on permit violations including February 1994 violations in Ruby Gulch (EPA 2000b).

February 20, 1997 – The SDDENR issued a NOV for the discharge of acid mine discharges into Strawberry Creek. Brohm paid a $5,400 penalty.

September 15, 1997 - The SDDENR issued a NOV for two discharges of acid mine drainage into Strawberry Creek. Brohm paid a $18,000 penalty.

September 5, 1998 - SDDENR issued a NOV and Order for Compliance for NPDES permit violations (including cadmium, copper, zinc) at Strawberry Creek Compliance Point 001 in 1996, 1997, and 1998 (EPA 2000b).

March 31, 1994 through January 31, 2000 - Numerical violations of NPDES permit limits at Compliance Points 001 and 002 (EPA 2000b).

July 1999 - The SDDENR averted an acid water discharge by operating necessary water treatment operations at the Site using the State's Regulated Substance Response Fund. SDDENR maintained the water treatment plant to remove metals using standard pH adjustment methods with sludges discharged back into an open pit.

1999 - UOS prepared the SI for the Site in 1999. Soil, sediment, and surface water sampled were collected and analyzed for heavy metals and cyanide during the SI (UOS 1999).

February 2000 - The Governor of South Dakota requested that EPA propose the Site for the Superfund NPL and provide emergency response, as well as long-term remedial cleanup. The Site was proposed for NPL listing on May 11, 2000. The final listing of the Site was on December 1, 2000.

Present - Superfund removal and remedial programs have begun cleanup remedial investigations and feasibility studies. EPA Region VIII Emergency Response Team has been maintaining interim water treatment operations since August 2000. Site management and water treatment requirements are severely straining Region VIII emergency response budget and the ability for EPA to respond to additional emergency response needs elsewhere. This record of decision (ROD) will transfer funding responsibility for water management and treatment operations to the Superfund Remedial Program, which has responsibility for long-term remedial response actions.

2.6 Site Reclamation and Planned Remedial Actions for Waste Isolation and Drainage Control

Containment/isolation and stabilization actions planned onsite are expected to be conducted in five phases with the first three phases containing the major portion of the Site reclamation. The activities in each phase are listed below.

Activity
Phase I
Divert clean drainage around Ruby Dump and Ruby Collection Pond.
Cap and reclaim lower 2/3 of Ruby Dump.
Dakota Maid Pit - Pump down, plug mine workings, line, and begin backfilling.
Reclaim portions of Road C fill and facilities areas. Direct runoff directly to Strawberry Creek.
Complete backfilling and cap and reclaim Dakota Maid Pit.
Phase II
Anchor Hill Pit - Pump down and install liner.
Backfill Anchor Hill Pit (material from Ruby Dump and heap leach pad [HLP]).
Cap and reclaim Anchor Hill Pit.
Cap and reclaim upper 1/3 of Ruby Dump.
Regrade, cap, and reclaim Spent Ore Repository Area.
Partially backfill and reclaim the southeast Langley Pit Area.
Phase III
Sunday Pit - Pump down, remove dam, line, and backfill (material from HLP and Hoodoo Gulch Road fill).
Cap and reclaim Sunday Pit.
Reclaim HLP.
Reclaim Hoodoo Gulch Disturbed Area.
Reclaim Crusher Area.
Reclaim remaining disturbed areas.
Phase IV
Remove Pond D and reclaim.
Phase V
Reconfigure Pond E and reclaim.

Upon completion of Site reclamation and remedial actions, it is anticipated that ARD generation from the Site will be significantly reduced. The post closure water treatment flow rate is estimated to be 60 gpm (BOR 2000). This reduction will allow for scaled down ARD treatment and containment facilities.

2.7 Interim Action Requirements

Until Site reclamation and closure activities are complete, containment and treatment of ARD generated from the Site is required to protect human health and the environment.

2.7.1 ARD Flow Rates

ARD generation at the Site is composed of surface water runoff and groundwater contributions from underground mine workings and the open mine pits. Preliminary calculations of surface water runoff based on estimated annual average precipitation (27 inches) and limited data for groundwater contributions from the mine workings indicate that the Site will generate an annual average ARD flow rate of approximately 170 gpm. The same preliminary calculations and data indicate that for the maximum annual precipitation (approximately 43 inches over the period of record [1909 to 1999 at Lead]) the Site will generate an annual ARD flow rate of 375 gpm. These flow rates are based on the Site water balance model. The reader is asked to refer to Gilt Edge Mine Background Report (CDM Federal 2001) for a complete description of the Site water balance model.

2.7.2 ARD Composition

Composition of ARD at the Site is varied by source. However, current Site practice is to route all ARD to the Sunday Pit prior to treatment; data collected on the composition of Sunday Pit water has been used as an estimate of overall Site ARD composition. Additionally, only limited data exists for water treatment plant influent composition. Table 2-1 presents the estimated composition of Site ARD based on averages of Sunday Pit sampling data collected from July 27, 1993 through June 6, 2000.

Table 2-1 Estimated Composition of Site ARD

Parameter	Concentration
Ammonia as N	1.6 mg/L
Nitrate as N	11 mg/L
pH	Range = 2.5 - 3.4 Average = 2.85
Total Suspended Solids (TSS)	25 mg/L
Temperature	49°F
Metals (dissolved)	
Aluminum	240 mg/L
Antimony	0.0027 mg/L
Arsenic	0.51 mg/L
Barium	0.057 mg/L
Beryllium	0.035 mg/L
Cadmium	0.67 mg/L
Calcium	360 mg/L
Chromium (III)	Combined total
Chromium (VI)	0.10 mg/L
Cobalt	1.2 mg/L
Copper	68 mg/L
Gold	0.0047 mg/L
Iron	270 mg/L
Lead	0.017 mg/L
Lithium	0.16 mg/L
Magnesium	160 mg/L
Manganese	26 mg/L
Mercury	0.0002 mg/L
Molybdenum	0.0087 mg/L
Nickel	0.74 mg/L
Potassium	2.6 mg/L
Selenium	0.017 mg/L
Silicon	28 mg/L
Silver	0.0034 mg/L
Sodium	410 mg/L
Strontium	2.6 mg/L
Thallium	0.022 mg/L
Vanadium	0.058 mg/L
Zinc	20 mg/L
Cyanide (weak-acid dissociable)	0.01 mg/L
Total Dissolved Solids (TDS)	6,300 mg/L
Chloride	37 mg/L
Sulfate	4,200 mg/L
Hardness (mg/L as $CaCO_3$)	1,550 mg/L

Section 3
Remedial Action Objectives and Remedial Action Goals

3.1 Preliminary Interim Remedial Action Objectives and Goals

According to the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 Code of Federal Regulations [CFR] 300.430(a)(1)(I)), the goal of the remedy selection process is "to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste." The remediation goals and objectives for the Gilt Edge Mine Site interim water treatment action presented below are initially based on the established ARARs, criteria, or limitations of the state of South Dakota and federal laws and state facility siting laws in effect during and at the completion of the remedial action.

As directed by EPA, the FFS will consider the potential for current and future use of the site and downstream drainages in the development of the IRAOs and IRAGs for the interim water treatment remedial action. The FFS will also consider the long-term water treatment requirements at the Site in establishing the IRAOs and IRAGs.

The alternatives selected in this report should meet both the IRAOs and IRAGs established for the chemicals of potential concern (COPC). The final assessment of remedial actions at the Site will include the analysis of long-term closure activities for the treatment of ARD.

For this FFS, IRAOs and IRAGs have been defined as follows: IRAOs - narrative statements that describe the intent of the action(s), and IRAGs - numeric standards that specify water treatment goals. The IRAOs have been developed as qualitative objectives for the protection of the environment based on overall site remedial actions and closure activities, current and future site uses, and efforts to minimize interim water treatment costs at the Site. IRAGs have been established based on existing site-specific standards under current state and federal law for stream segments in and around the site. These IRAGs are the quantitative treatment levels needed to meet the protective criteria and objectives established by the IRAOs.

3.1.1 Interim Remedial Action Objectives

The following IRAOs were defined for the interim water treatment action:

- Prevent direct exposure of the population to elevated concentrations of contaminants in surface water drainage from the Site
- To reduce or eliminate ARD water flow into Ruby Gulch and Strawberry and Bear Butte Creeks

- To minimize expenditures for water treatment at the Site during closure activities (determine a preliminary minimum cost to closure comparison between recommended alternatives, based on present worth analysis)
- Minimize waste and waste disposal requirements
- Integrate water treatment with overall Site closure and reclamation activities
- Maintain compatibility with sitewide remedial action objectives and final water treatment remedial action

3.1.2 Interim Remedial Action Goals

Surface water quality standards adopted by the state of South Dakota for toxic pollutants for aquatic life (ARSD §74:51:01:55), for total dissolved solids for fish and wildlife propagation, recreation, and stock watering (ARSD §74:51:01:52), and for coldwater marginal fish life propagation waters (ARSD §74:51:01:46), were used to determine IRAGs for the Site water treatment interim remedial action based on their identification as ARARs. Table 3-1 presents a summary of these standards for COPCs at the Site.

Table 3-1 Summary of ARAR Surface Water Quality Standards

ARAR	Constituent	Standard	Site Water Quality[C]	Units
ARSD §74:51:01:55	Arsenic	190	510	µg/L
ARSD §74:51:01:55	Cadmium	2.87[A]	670	µg/L
ARSD §74:51:01:55	Chromium (III)	554[A]	Combined Total = 100	µg/L
	Chromium (VI)	10		µg/L
ARSD §74:51:01:55	Copper	37.11[A]	68,000	µg/L
ARSD §74:51:01:55	Lead	10.94[A]	17	µg/L
ARSD §74:51:01:55	Mercury	0.012[B]	0.2	µg/L
ARSD §74:51:01:55	Nickel	507.89[A]	740	µg/L
ARSD §74:51:01:55	Selenium	5	17	µg/L
ARSD §74:51:01:55	Silver	37.4[A]	3.4	µg/L
ARSD §74:51:01:55	Zinc	338.28[A]	20,000	µg/L
ARSD §74:51:01:55	Cyanide (weak acid dissociable)	5.2	10	µg/L
ARSD §74:51:01:52	Nitrate as N	≤50	11	mg/L
ARSD §74:51:01:52	Total Dissolved Solids (TDS)	≤2,500	6,300	mg/L
ARSD §74:51:01:46	pH	6.6-8.6	2.9	Standard units
ARSD §74:51:01:46	TSS	≤90	25	mg/L

Note: Metals limits are dissolved unless otherwise noted.

[A] Hardness dependent criteria in µg/L. Value given is based on a $CaCO_3$ hardness of 400 mg/L. Criteria for other hardness values must be calculated using the equations taken from Quality Criteria for Water 1986 (Gold Book).

[B] Criteria based on total recoverable fraction of the metal.

[C] Averages of Sunday Pit sampling data collected from July 27, 1993 through June 6, 2000.

From the above listed standards, the IRAGs were established and are presented in Table 3-2.

Table 3-2 Preliminary Interim Remedial Action Goals

Analyte	Influent	Effluent	Units
Arsenic	510	190[A]	µg/L
Cadmium	670	2.87[AD]	µg/L
Chromium (III)	Combined Total = 100	554[AD]	µg/L
Chromium (VI)		10	µg/L
Copper	68,000	37.11[AD]	µg/L
Lead	17	10.94[AD]	µg/L
Mercury	0.2	0.012[AF]	µg/L
Nickel	740	507.89[AD]	µg/L
Selenium	17	5[A]	µg/L
Silver	3.4	37.4[AD]	µg/L
Zinc	20,000	100[AD]	µg/L
Cyanide (weak acid dissociable)	10	5.2[A]	µg/L
Total Dissolved Solids (TDS)	6,300	2,500[B]	mg/L
pH	2.9	6.6-8.6[C]	Standard Units
TSS	25	≤90[CE]	mg/L

Note: Metals limits are dissolved unless otherwise noted.

NE Not Established

A Limit established by ARSD§ 74:51:01:55

B Limit established by ARSD§ 74:51:01:52

C Limit established by ARSD§ 74:51:01:46

D Hardness dependent criteria in µg/L. Value given is based on a $CaCO_3$ hardness of 400 mg/L. Criteria for other hardness values must be calculated using the equations taken from Quality Criteria for Water 1986 (Gold Book).

E Established for compliance point 001.

F Criteria based on total recoverable fraction of the metal.

In order for surface water leaving the Site to meet these IRAGs, active treatment will be required. As developed in Sections 4 and 5 of this report, no single unit process from any of the remedial technologies reviewed is capable of meeting all of these goals. Therefore, the alternatives developed in Section 5 include multiple unit processes from several remedial technology categories and describe the capabilities and/or limitations of each. Section 5 describes alternatives that achieve ARAR compliance and also presents alternatives predicated on an interim waiver of selected ARAR standards.

3.2 Applicable or Relevant and Appropriate Requirements

3.2.1 Definition of ARARs

Section 121(d) of CERCLA, 42 U.S.C. §9621(d), the NCP, 40 CFR Part 300 (1990), and guidance and policy issued by EPA require that remedial actions under CERCLA comply with substantive provisions of ARARs from state of South Dakota and federal environmental laws and state facility siting laws during and at the completion of the remedial action. ARARs are either "applicable" or "relevant and appropriate." Both

types of requirements are mandatory under CERCLA and the NCP. These requirements are threshold standards that any selected remedy must meet, unless an ARAR waiver is invoked.

Appendix A identifies ARARs for potential activities to be conducted under the Site interim water treatment remedial action. The ARARs, or groups of related ARARs, included in Appendix A are identified by a statutory or regulatory citation, followed by a brief explanation of the ARAR and how and to what extent the ARAR is expected to apply to potential activities to be conducted under this interim water treatment remedial action.

Substantive provisions of the requirements listed in Appendix A are identified as ARARs pursuant to 40 CFR §300.400. ARARs that are within the scope of this remedial action must be attained during and at the completion of the remedial action [40 CFR §300.435(b)(2)]. No permits are anticipated for a remedial action for Site water treatment interim remedial action in accordance with Section 121(e) of CERCLA.

3.2.1.1 Applicable Requirements

Applicable requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental and facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and those that are more stringent than federal requirements may be applicable (40 CFR §300.5).

3.2.1.2 Relevant and Appropriate Requirements

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that, while not "applicable" to hazardous substances, pollutants, contaminants, remedial actions, locations, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than federal requirements may be relevant and appropriate (40 CFR §300.5).

The determination that a requirement is relevant and appropriate is a two-step process: (1) determination if a requirement is relevant, and (2) determination if a requirement is appropriate. In general, this involves a comparison of a number of site-specific factors, including an examination of the purpose of the requirement and the purpose of the proposed CERCLA action; the medium and substances regulated by the requirement and the proposed requirement; the actions or activities regulated by the requirement and the remedial action; and the potential use of resources addressed in the requirement and the remedial action. When the analysis results in a

determination that a requirement is both relevant and appropriate, such a requirement must be complied with to the same degree as if it were applicable (EPA 1988).

3.2.1.3 Other Requirements to be Considered

Many requirements listed as ARARs are promulgated as identical or near identical requirements in both federal and state law, usually pursuant to delegated environmental programs administered by EPA and the state. The Preamble to the NCP provides that such a situation results in citation to the state provision and treatment of the provision as a federal requirement.

Also contained in this list are policies, guidance, or other sources of information that are to be considered in the selection of the remedy and implementation of the ROD. Although not enforceable requirements, these documents are important sources of information that EPA and the state may consider during selection of the remedy, especially in regard to the evaluation of public health and environmental risks; or that will be referred to, as appropriate, in selecting and developing cleanup actions [40 CFR §300.400(g)(3), 40 CFR §300.415(I)].

3.2.1.4 Waivers of Specific ARARs

CERCLA Section 121(d)(4) authorizes that any ARAR may be waived under one of the following six conditions if the protection of human health and the environment is assured:

- It is part of a total remedial action that will attain such level or standard of control when completed.
- Compliance with the ARAR at a given site will result in greater risk to human health and the environment than alternative options that do not comply with the ARAR.
- Compliance with such a requirement is technically impracticable from an engineering perspective.
- The remedial action will attain a standard or performance equivalent to that required by the ARARs through use of another method or approach.
- The ARAR in question is a state standard and the state has not consistently applied (or demonstrated the intention to consistently apply) the ARAR in similar circumstances at other sites.
- In meeting the ARAR, the selected remedial action will not provide a balance between the need for protection of public health and welfare and the environment at the Site and the availability of Superfund monies to respond to other facilities.

3.2.2 Identification of ARARs

ARARs are contaminant-, location-, or action-specific. Contaminant-specific requirements address chemical or physical characteristics of compounds or substances on sites. These values establish acceptable amounts or concentrations of chemicals that may be found in or discharged to the ambient environment.

Location-specific requirements are restrictions placed upon the concentrations of hazardous substances or the conduct of cleanup activities because they are in specific locations. Location-specific ARARs relate to the geographical or physical positions of sites, rather than to the nature of contaminants at sites.

Action-specific requirements are usually technology-based or activity-based requirements or limitations on actions taken with respect to hazardous substances, pollutants, or contaminants. A given cleanup activity will trigger an action-specific requirement. Such requirements do not themselves determine the cleanup alternative, but define how chosen cleanup methods should be performed.

Appendix A constitutes the initial identification and detailed description of ARARs for the implementation of an interim water treatment action at the Gilt Edge Mine Site. Final ARARs will be set forth as performance standards for any and all remedial design or remedial action work plans. As discussed in paragraph 3.1, the IRAGs are developed from the surface water quality ARARs found in Appendix A.

Section 4
Identification and Screening of General Response Actions, Technologies, and Process Options

General response actions (GRAs) are initial broad treatment actions considered for applicability based on the type of media anticipated at a site. These GRAs include several categories such as containment, removal, treatment, and disposal of hazardous substances. In a typical FS, site-specific GRAs are first developed to satisfy the preliminary remedial action objectives for the media identified at a site. Then, a list of all known remediation technologies within each category of the GRAs is compiled and screened for implementability at that particular site. In this FFS, site-specific GRAs were developed for the ARD media identified at the Site. The GRAs developed do not necessarily satisfy all the IRAOs developed in Section 3 but have been included to show a comprehensive list of the possible actions that could be taken with respect to the ARD media at the Site. Next a list of applicable remediation technologies and process options within each category of the GRAs was compiled for screening with respect to implementability.

The following sections present the six GRAs to be evaluated as part of the screening process, the preliminary screening of technologies and process options, and the evaluation of the retained technologies and process options for the Site interim water treatment remedial action. The result of this initial screening process is presentation of the process options for each remedial technology that are suitable for incorporation into remedial action alternatives. Remedial action alternatives based on the GRAs and technology process options retained after screening are developed and evaluated further for effectiveness, implementability, and cost in Section 5.

4.1 General Response Actions

The general response actions considered likely for site remediation are presented in Table 4-1. These GRAs will be reviewed in the FFS, in addition to the No Action alternative.

Table 4-1 General Response Actions

General Response Action	Description
No Action	No control or cleanup of source contamination. Serves as baseline for comparison.
Institutional Controls	Administrative or legal restrictions applied to the source site intended to control or prevent present and future use and access to the source.
Engineered Controls	Physical restrictions applied to the source site intended to control or prevent present and future use and access to the source.
Containment	Physical restrictions applied to the sources to control release of contaminants.
Active Treatment	Physical and/or chemical measures applied to the source material that reduce the toxicity, mobility, and/or volume of the contaminants present.
Passive Treatment	Constructed environment or feature that contacts the source material and reduces the toxicity, mobility, and or volume of the contaminants present without the addition of reagents or energy.

No Action leaves sources in their existing condition with no control or cleanup planned. In accordance with the NCP, the No Action alternative must be retained for consideration to provide a baseline against which other options can be compared.

Institutional Controls are administrative and legal restrictions intended to control or prevent present and future use of source areas. Institutional controls are not intended to substitute for engineering aspects of a remedy.

Engineered Controls are physical restrictions intended to control or prevent present and future access to source areas.

Containment involves physical measures applied to sources to control the release of contaminants or direct contact or exposure.

Active Treatment involves physical or chemical measures applied to the source materials that reduce toxicity, mobility, and/or volume of the contaminants present.

Passive Treatment involves use of a constructed environment or feature that contacts the source material to reduce toxicity, mobility, and/or volume of the contaminants present without the addition of reagents or energy.

4.2 Identification and Screening of Technologies and Process Options

Technologies and process options applicable to each GRA and the media at the Site were identified and screened on the basis of technical feasibility. The feasibility of a technology or process option was evaluated based primarily upon type of contamination, contamination concentrations, treatment volumes and rates, and site conditions. The technologies and process options for the Gilt Edge Mine interim water treatment remedial action are identified in paragraph 4.2.1 and are screened with respect to technology implementability in paragraph 4.2.2.

4.2.1 Identification of Potentially Applicable Technologies and Process Options

Based on review of EPA documentation and other pertinent references and experiences in mining ARD remediation, a master list of potential remedial technologies and process options that are potentially feasible and implementable for the Gilt Edge Mine interim water treatment remedial action has been developed. The technologies and process options corresponding to the GRAs are presented and described in Table 4-2 along with screening comments. Results of the screening are presented in paragraph 4.3.

Table 4-2 Description and Initial Screening of Potentially Applicable Remedial Technologies and Process Options

General Response Actions	Remedial Technology	Process Option	Description of Option	Screening Comments	Retained
No Action	None	None	No action would be taken. The source area remains in its existing condition.	Required by NCP as baseline for comparison.	Yes
Institutional Controls	Land Use Controls	Governmental and Proprietary Controls	Source site would have zoning and restrictions governing land use of the Site.	*Not effective* in reducing toxicity, mobility, or volume. Does not comply with ARARs.	No
	Community Awareness	Information and Education Programs	Community information and educational programs would be undertaken to enhance awareness of potential hazards and remedies.	*Not effective* in reducing toxicity, mobility, or volume. Does not comply with ARARs.	No
Engineered Controls	Access Restrictions	Fencing and Posted Warnings	Source would be enclosed by fences and warning signs to control access.	*Not effective* in reducing toxicity, mobility, or volume. Does not comply with ARARs.	No
Hydraulic Controls	Containment	Storage Ponds	Surface water and contributing groundwater would be stored in existing open pits and/or newly constructed storage ponds.	*Not effective* in reducing toxicity, mobility, or volume. Would eventually allow release of ARD from the Site. Does not allow other remedial actions to proceed.	No
		Storage Tanks	Surface water and contributing groundwater would be stored in above ground or below grade storage tanks.	*Not effective* in reducing toxicity, mobility, or volume. Would eventually allow release of ARD from the Site. Does not allow other remedial actions to proceed.	No
	Surface Water Runoff/ Runon Controls	Diversion Ditches	Use of diversion ditches to prevent surface water runon to the Site to reduce overall surface water runoff from the Site.	*Limited effectiveness.* Some diversions already exist. Additional diversions will be constructed as part of other remedial actions at the Site. Diversions can only reduce and not eliminate the need for treatment.	No
	Collection and transmission	Sump collection and tank storage with gravity flow and pumped transmission	Sumps used at individual seeps for collection of ARD in different drainage basins on the Site. Tank storage of collected seep water for pumped transmission to treatment.	*Effective and implementable* for ARD seep collection to provide subsequent treatment. Minimizes treatment volume due to direct collection.	Yes
		Pond collection and storage with gravity flow and pumped transmission	Ponds downstream of seeps used to collect ARD from different drainage basins on the Site with transmission to treatment.	*Not effective* in minimizing required treatment volume due to collection of additional "clean" surface water runoff along with seep flows.	No

Table 4-2 Description and Initial Screening of Potentially Applicable Remedial Technologies and Process Options

General Response Actions	Remedial Technology	Process Option	Description of Option	Screening Comments	Retained
Active Treatment	Physical Separation	Microfiltration	Capable of removing chemical compounds and larger size particles from liquid streams.	*Effective and implementable* for precipitate and other chemical compound removal.	Yes
		Nanofiltration	Capable of removing multivalent ions and larger size particles from liquid streams.	*Effective and implementable* for sulfate ion TDS removal.	Yes
		Reverse Osmosis	Capable of removing single valent ions and larger size particles from liquid streams.	*Effective and implementable* for TDS removal.	Yes
		Granular Medium Filtration	Use of granular medium filter beds to remove suspended solids from a liquid stream.	*Effective and implementable* for removal of suspended solids created by precipitation processes. Combined with fabric medium filtration as one retained process option.	Yes
		Fabric Medium Filtration	Use of cloth, metal, or synthetic fabric to remove suspended solids from a liquid stream.	*Effective and implementable* for removal of suspended solids created by precipitation processes. Combined with granular medium filtration as one retained process option.	Yes
		Sedimentation/ Clarification	Use of gravity sedimentation/clarification basins for separation of suspended solids from a liquid stream.	*Effective and implementable* for removal of suspended solids created by precipitation processes.	Yes
		Carbon Adsorption	Removes metal ions and other species from liquid streams by filtration and adsorption.	*Limited effectiveness* for metals removal. *High cost* associated with large volume of spent carbon.	No
		Mechanical Evaporation	Input of heat energy and/or reduction in pressure to cause vaporization of a liquid stream to separate solid contaminants.	*Effective and implementable* for metals and TDS removal from side streams generated from other processes. *High cost* for energy.	Yes
	Chemical	Neutralization/ Precipitation (N/P)	Sodium hydroxide, quicklime, hydrated lime, sodium carbonate, sodium sulfide/ferrous sulfate, or other N/P chemical reagents are used to form insoluble metal precipitates and adjust pH.	*Effective and implementable* for metals removal and pH adjustment. Currently sodium hydroxide is used in the existing N/P water treatment plant. Technically feasible. Other N/P chemical reagents may be more efficient and cost effective.	Yes

Table 4-2 Description and Initial Screening of Potentially Applicable Remedial Technologies and Process Options

General Response Actions	Remedial Technology	Process Option	Description of Option	Screening Comments	Retained
Active Treatment (cont.)	Chemical (cont.)	Ion Exchange	Ions of a particular species are displaced from an insoluble exchange material by ions of a different species.	*Effective and implementable* for metals removal.	Yes
		Microencapsulation	Chemical that either coats or reacts with metals to form an insoluble coating.	Silica microencapsulation pilot study will be performed to determine effectiveness in meeting metals removal ARARs.	Yes
		Metals Coordination	Use of proprietary blend of chemicals to produce an insoluble coordinated metal complex allowing solids/liquid separation.	Potentially *effective and implementable* for removal of metals including selenium with some reduction in TDS.	Yes
	Biological	Sulfate Reduction/Sulfide Precipitation	Bioreactor for microbial metabolic conversion of sulfate to sulfide allowing for precipitation of insoluble metal sulfides.	*Effective and implementable* for metals and sulfate removal by sulfide precipitation.	Yes
Passive Treatment	Physical/ Chemical/ Biological	Constructed Wetlands	Constructed marshes, bogs, wet meadows, peat lands, and swamps would be used for the assimilative capacity of metals (naturally occurring sulfate reducing bacteria produce sulfide that precipitates metals).	*Not implementable* due to high treatment flow rate requirements, low efficiency, less than ideal climate, and site topography.	No
	Chemical/ Physical	Anoxic Limestone Drains	Bicarbonate alkalinity dissolved from constructed limestone drains adjusts pH. Adjusted pH provides for limited metals removal by precipitation.	*Not implementable* due to area requirements and site disturbance during site closure activities. Not effective for TDS removal.	No
	Physical	Evaporation	Construction of large surface area ponds to take advantage of naturally occurring vaporization allowing solid contaminant separation from a liquid stream.	*Not implementable* since average annual precipitation for the Site is approximately twice the average annual evaporation from the Site.	No
Varied	Innovative	Electrocoagulation	Electrical energy supplied to sacrificial anodes and cathodes create insoluble precipitates for metals removal.	Shows *effectiveness* for metals removal from waste streams. Has not yet been applied to ARD. *Implementability* could be difficult due to recent emergence of technology. Retained as innovative technology.	Yes

4.2.2 Screening of Potentially Applicable Technologies and Process Options

The technologies and process options identified in Table 4-2 as applicable to the water treatment interim remedial action were evaluated with respect to technical feasibility at the Site. The process options were evaluated on the basis of effectiveness, implementability, and relative cost, as outlined in the following sections discussing the application of these criteria. The lower cost alternative was used to exclude a competing process option or technology in cases where the evaluation of the first two criteria did not reveal significant or sufficient differences in effectiveness or implementability with regard to the specific conditions at the Site. Table 4-2 presents each GRA, process option, and screening comments.

4.2.2.1 Effectiveness

This criterion focuses on the following factors for the effectiveness of the process options: degree to which an option reduces toxicity, mobility, or volume through treatment; minimizes residual risks and affords long-term protection; complies with ARARs; and minimizes short-term impacts, as well as how quickly it achieves protection. Options providing significantly less effectiveness than other, more promising options may be eliminated. Options that do not provide adequate protection of human health and the environment are eliminated from further consideration.

4.2.2.2 Implementability

The criterion for the implementability of process options is based on the technical feasibility and availability of each option and the administrative feasibility of implementing the option (for example, obtaining permits for offsite activities or rights-of-way for construction). Options that are technically or administratively infeasible or that would require equipment, specialists, or facilities that are not available within a reasonable period of time may be eliminated from further consideration.

4.2.2.3 Cost

This criterion focuses on the relative total present worth costs of construction and any long-term costs to operate and maintain an option. These costs were based on rough engineering estimates derived from historical costs for the process options and technologies. Costs that are grossly excessive compared to the overall effectiveness of an option may be considered as one of several factors used to eliminate options.

4.3 Remedial Technologies and Process Options Carried Forward for the Development of Remedial Alternatives

Based on the results of the screening described in the previous section, a reduced number of remedial technologies and process options were retained for further

evaluation and the development of remedial alternatives. Table 4-3 presents these retained technologies and process options.

Table 4-3 Retained Remedial Technologies and Process Options

General Response Actions	Remedial Technology	Process Option
No Action	None	None
Hydraulic Controls	Collection and Transmission	Sump collection and tank storage with gravity flow and pumped transmission
Active Treatment	Physical Separation	Microfiltration
		Nanofiltration
		Reverse Osmosis
		Fabric/Granular Medium Filtration
		Sedimentation/Clarification
		Mechanical Evaporation
	Chemical	Neutralization/Precipitation
		Ion Exchange
		Electrocoagulation
		Microencapsulation
		Metals coordination
	Biological	Metabolic (anaerobic) sulfate reduction/sulfide precipitation

Section 5
Development and Screening of Alternatives

5.1 Development of Preliminary Interim Remedial Action Alternatives

In this section, preliminary interim remedial action alternatives for ARD treatment are assembled by combining the GRA and process options retained for further evaluation (Table 4-3) as discussed in paragraph 4.3. Remedial action alternatives are developed from either stand-alone options or combinations of the screened process options. These alternatives are preliminarily screened for interim-term effectiveness, implementability, and cost in Section 5, and then analyzed in detail for effectiveness; overall protection of human health and the environment; reduction of toxicity, mobility, and volume of contamination; and compliance with ARARs in Sections 6 and 7.

The preliminary remedial action alternatives for the Site interim water treatment action span a range of categories defined by the NCP as follows:

- No action alternative
- Alternatives that, as their principal element, employ treatment that reduces the toxicity, mobility, or volume of the contaminants
- Alternatives that remove or destroy contaminants to the maximum extent, eliminating or minimizing long-term management
- Alternatives that include innovative treatment technologies

Table 5-1 presents a summary of the description and screening of alternatives and is located in paragraph 5.4. of this section.

5.2 Description of Alternatives

The following remedial action alternatives have been assembled for ARD treatment at the Site. The alternatives are assembled as representative combinations of the retained technologies and process options of the GRAs identified in Section 4, and are based on industry standard ARD unit process treatment trains and experience on similar treatment applications. The alternatives have been divided into six categories with respect to the use of the existing WTP and bucket treatment systems, ARD collection and transmission, and compliance with ARARs. It is noted that Alternative 3, addressing the collection and transmission of ARD seeps in the Hoodoo Gulch and Pond C drainage basins, must be selected along with a process option described in Alternatives 4, 5, or 6. The six approaches, identified as Alternatives 1 through 6, addressed herein are:

- Alternative 1: No Action
- Alternative 2: Continue Treatment of ARD with Existing WTP, and Pond C and Hoodoo Gulch Hydroxide Bucket Method
- Alternative 3: Route Hoodoo Gulch and Pond C ARD to WTP (with Alternative 4, 5, or 6)
  - Alternative 3a: Divert ARD Seep Flows from Hoodoo Gulch to Sunday Pit; Divert Pond C ARD Seep Flows to Pond D
  - Alternative 3b: Divert ARD Seep Flows from Hoodoo Gulch to Strawberry Pond; Divert Pond C ARD Seep Flows to Pond D
- Alternative 4: Upgrade Existing ARD WTP to Meet ARARs (with Alternative 3)
  - Alternative 4a: Follow Existing Chemical Precipitation with Full Stream Membrane Filtration
  - Alternative 4b: Replace Existing Sodium Hydroxide Chemical Precipitation with Lime Addition, Proprietary Sulfate Removal Process, and pH Adjustment
- Alternative 5: Construct New ARD WTP to Meet ARARs (with Alternative 3)
  - Alternative 5a: Caustic Addition, Chemical Precipitation, and Full Stream Membrane Filtration
  - Alternative 5b: Lime Addition, Chemical Precipitation, and Partial Stream Membrane Filtration
  - Alternative 5c: Lime Addition, Chemical Precipitation, Proprietary Sulfate Removal Process and pH Adjustment
  - Alternative 5d: Ion Exchange Full Stream Membrane Filtration, and pH Adjustment
  - Alternative 5e: Electrocoagulation and Partial Stream Membrane Filtration
  - Alternative 5f: Anaerobic Sulfate Reduction, Metal Sulfide/Carbonate Precipitation, and Partial Stream Membrane Filtration
  - Alternative 5g: Proprietary Microencapsulation/Precipitation, and Full Stream Membrane Filtration
  - Alternative 5h: Optimized Chemical Precipitation Using Proprietary Metals Coordination Process and Full Stream Membrane Filtration
- Alternative 6: Construct/Upgrade ARD WTP with Interim ARAR Waiver (with Alternative 3)

— Alternative 6a: Upgrade Existing Caustic Chemical Precipitation ARD WTP With Additional Treatment Train and Filtration (Interim ARAR Waiver)

— Alternative 6b: Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Addition and Upgrade With Additional Treatment Train and Filtration (Interim ARAR Waiver)

— Alternative 6c: Construct New Proprietary Microencapsulation/Precipitation ARD WTP (Interim ARAR Waiver)

— Alternative 6d: Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (Interim ARAR Waiver)

Alternatives developed for Alternative 6 (Construct/Upgrade ARD WTP with Interim ARAR Waiver) include only those technologies that can be implemented within a short time frame at moderate to high costs (no low cost technologies are feasible at the Site). No technologies were included that would require extensive pilot testing or that have very high costs associated with them. Therefore, ion exchange and electrocoagulation were not included in this alternative due to the very high costs. Additionally, anaerobic sulfate reduction was also not included due to the extensive pilot testing (greater than 1 year) required to determine effectiveness and feasibility of this technology.

The following sections provide detailed descriptions of these alternatives to be evaluated for the treatment of ARD.

5.2.1 Alternative 1 – No Action

The No Action alternative would discontinue treatment of ARD by the existing WTP and would allow all additional ARD flows above the current storage capacity of the open mine pits to migrate offsite untreated through the existing drainages to Strawberry and Bear Butte Creeks. There would be no change in ARD contaminant concentrations because no treatment, containment, or removal of waste is included in this alternative. Alternative 1 includes surface water monitoring and 5-year site reviews since ARD would be discharged from the Site and remain in storage in the onsite open pits.

5.2.2 Alternative 2 – Continue Treatment of ARD with Existing WTP, and Pond C and Hoodoo Gulch Hydroxide Bucket Method

Under this alternative, ARD would continue to be collected in the Ruby Gulch pond and pumped to the WTP; the ARD seep flows in Hoodoo Gulch and upstream of Pond C would be treated using the sodium hydroxide (NaOH) bucket method; and no upgrades would be made to the WTP. The existing bucket method consists of a series of 5-gallon plastic buckets containing NaOH through which the seep flows are directed.

As part of the current optimization of the existing WTP, the BOR is adding ferric chloride to increase iron co-precipitation of metals and sludge is directed to the stormwater collection pond. A filter press is expected to be installed, as part of the BOR optimization strategies, to manage sludge residuals, with onsite residual disposal in the existing lined pits. The optimized capacity of the existing WTP is anticipated to be 250 gpm. No additional treatment measures beyond those described would be implemented at the Site.

Alternative 2 also includes: operations and maintenance (O&M) of the existing ARD collection, transmission, and treatment systems; and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.3 Alternative 3a – Divert ARD Seep Flows from Hoodoo Gulch to Sunday Pit; Divert ARD Seep Flows from Pond C to Pond D

The seep flows from Hoodoo Gulch would be collected in sumps at the individual seeps and conveyed to a storage tank located at a downstream collection point prior to convergence with Strawberry Creek. Collected water would subsequently be pumped to Sunday Pit via a new buried pipeline. The seep flows upstream (east) of Pond C would be intercepted as surface water run off in a HDPE lined channel located to the east of Pond C. The channel would provide gravity flow to the south, with discharge to Pond D. The routing of Hoodoo Gulch (via Sunday Pit) and Pond C (via Pond D) seep flows to the WTP would ensure treatment and reduce the contaminant loadings to Strawberry Creek. This alternative would be chosen along with an upgrade to the existing WTP (Alternative 4), new WTP construction (Alternative 5), or an interim ARAR waiver WTP alternative (Alternative 6).

Alternative 3a also includes O&M of the pumping system and cleaning of the collection tank and ARD channel.

5.2.4 Alternative 3b – Divert ARD Seep Flows from Hoodoo Gulch to Strawberry Pond; Divert Pond C Seep Flows to Pond D

Alternative 3b is similar to Alternative 3a except ARD seep flows from Hoodoo Gulch would be routed to Strawberry Pond via a new buried pipeline. This alternative would be chosen along with an upgrade to the existing WTP (Alternative 4), new WTP construction (Alternative 5), or an interim ARAR waiver WTP alternative (Alternative 6).

Alternative 3b also includes O&M of the pumping system and cleaning of the collection tank and ARD channel.

5.2.5 Alternative 4a – Follow Existing Chemical Precipitation with Full Stream Membrane Filtration

Upgrades to the existing ARD WTP (assuming an optimized treatment capacity of 300 gpm) would be made to increase operational efficiency, and to meet ARAR

requirements. The proposed process train additions would include acid pH adjustment following the existing lamella plate settler and the addition of microfiltration (MF) and nanofiltration (NF) membranes to reduce metal and TDS concentrations. The reject stream from the MF membrane would be blended with influent at the head of the plant; reject from the NF membrane would be routed to a mechanical evaporation unit. Sludge from the sedimentation unit would be managed using a filter press. The sludge and salts (from the evaporation unit) generated by the process would be disposed onsite in the existing lined pads and ponds.

Alternative 4a would also include: O&M of the upgraded existing ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.6 Alternative 4b – Replace Existing Sodium Hydroxide Chemical Precipitation with Lime Addition, Proprietary Sulfate Removal Process, and pH Adjustment

The upgrades considered in this alternative include converting from NaOH to lime addition and implementing a sulfate-specific removal process at a treatment capacity of 300 gpm. Lime addition would be used to raise the influent pH to 11. This addition would precipitate calcium sulfate ($CaSO_4$) in addition to other metal hydroxides. In addition, a proprietary process would be used to precipitate sulfate from the waste stream in a separate step. The process includes the addition of a chemical compound that reacts at a high pH to form a sulfate precipitate known as ettringite. The next step would be the precipitation of calcium (as calcium carbonate) by lowering the pH to effluent requirements using carbon dioxide or soda ash and acid. Sludge would be processed using a filter press and would be disposed onsite in the existing lined pads and ponds.

Alternative 4b would also include: O&M of the upgraded existing ARD WTP, and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.7 Alternative 5a – New ARD WTP with Caustic Addition, Chemical Precipitation, and Full Stream Membrane Filtration

Alternative 5a would include the construction of a new ARD WTP located south of Strawberry Creek Pond. This location was chosen for ease of access, to minimize pumping costs, and minimize impact on other site closure activities. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment. The new WTP would include two separate identical treatment trains, each having treatment capacity for approximately half the total 375 gpm influent flow.

Each process train would consist of chemical precipitation and membrane filtration. Caustic addition would be used to precipitate metal hydroxides. An outdoor circular clarifier would be used to settle the precipitates formed during treatment. Variations of this process include high density sludge recirculation. Resultant sludge would be processed using a filter press. Acid would be used to adjust pH to 7.0 prior to full stream membrane filtration. MF membranes would be used as a pretreatment step prior to the NF membranes. The MF reject would be blended with influent at the sludge recycle mix tank. The NF membrane would be used to reduce TDS concentrations and remove ions that are not precipitated by caustic addition (selenium). The NF reject would be processed using mechanical evaporation. For the purpose of this FFS, the processed sludge and salts (from the evaporation unit) are assumed to be disposed onsite in the existing lined pads and ponds.

Alternative 5a would also include: O&M of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.8 Alternative 5b – New ARD WTP with Lime Addition, Chemical Precipitation, and Partial Stream Membrane Filtration

Alternative 5b would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment. The new WTP would include two separate identical chemical precipitation treatment trains, each having treatment capacity for approximately half the total 375 gpm influent flow. These treatment trains would be followed by membrane filtration units having a treatment capacity of approximately 50 percent of the total 375 gpm influent flow.

Lime addition would be used to precipitate metal hydroxides. Variations of this process include high density sludge recirculation. An outdoor circular clarifier would be used to settle the precipitates formed during treatment. Resultant sludge would be processed using a filter press. Acid would be used to adjust pH to 7.0 prior to partial stream membrane filtration (approximately 50 percent). MF membranes would be used as a pretreatment step prior to the NF membranes. The MF reject would be blended with influent at the sludge recycle mix tank. The NF membrane would be used to reduce TDS concentrations and remove ions that are not precipitated by lime addition (selenium). The NF reject would be processed using mechanical evaporation. For the purpose of this FFS, the processed sludge and salts (from the evaporation unit) are assumed to be disposed onsite in the existing lined pads and ponds.

Alternative 5b would also include: O&M of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.9 Alternative 5c – New ARD WTP with Lime Addition, Chemical Precipitation, Proprietary Sulfate Removal Process, and pH Adjustment

Alternative 5c would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment. The new WTP would include two separate treatment trains, each having treatment capacity for approximately half the total 375 gpm influent flow.

Each treatment train would consist lime addition to raise the pH to 11, which precipitates $CaSO_4$ in addition to metal hydroxides. In addition, a proprietary sulfate removal process would be used to precipitate sulfate from the waste stream. The process includes the addition of a chemical compound that reacts at the high pH to form a sulfate precipitate known as ettringite. The process would be carried out through a series of chemical addition and clarifying steps. The next step would be the precipitation of calcium (as calcium carbonate) by lowering the pH, using carbon dioxide or soda ash and acid to effluent requirements. For the purpose of this FFS, the processed sludge is assumed to be disposed onsite in the existing lined ponds and pads.

Alternative 5c would also include: O&M of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.10 Alternative 5d – New ARD WTP with Ion Exchange, Full Stream Membrane Filtration, and pH Adjustment

Alternative 5d would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep for treatment. The new WTP would include two separate, identical treatment trains, each having treatment capacity for approximately half the total 375 gpm influent flow.

Each treatment process train would consist of ion exchange (IX) units for metals removal followed by full stream membrane filtration, as in Alternative 5a, for a total treatment capacity of 375 gpm. The membrane reject stream would be dewatered using a mechanical evaporation unit. Brine from IX regeneration would also be treated onsite using the evaporators and/or other sludge handling equipment. For the purpose of this FFS, the processed sludge, salts (from the evaporation unit) and other residuals are assumed to be disposed onsite in the existing lined ponds and pads.

Alternative 5d would also include: O&M of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with

Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.11 Alternative 5e – New ARD WTP with Electrocoagulation and Partial Stream Membrane Filtration

Alternative 5e would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment. The new WTP would include two separate treatment trains, each having treatment capacity for approximately half the total 375 gpm influent flow.

Each process train would use electrocoagulation (EC) units for the removal of metals and TDS. The EC unit would be a pretreatment step prior to partial stream membrane filtration. A partial stream (approximately 75 percent) of EC effluent would be routed through a MF membrane (with reject recycled to the head of the WTP), followed by a NF membrane to ensure reduction of TDS and selenium concentrations to below the ARAR limits of the discharge effluent when the sidestream and main effluent are blended back together. The NF reject would be processed through mechanical evaporation, and, for the purpose of this FFS, the processed sludge and salts (from the evaporation unit) are assumed to be disposed onsite in the existing lined ponds and pads.

Alternative 5e would also include: O&M of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.12 Alternative 5f – New ARD WTP Including Anaerobic Sulfate Reduction, Metal Sulfide/Carbonate Precipitation, and Partial Stream Membrane Filtration

Alternative 5f would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment. The new WTP would include two separate treatment trains, each having treatment capacity for approximately half the total 375 gpm influent flow.

This process includes anaerobic fluidized bed reactors with sulfate-reducing bacteria. Sulfate-reducing bacteria (Desulfovibrio and Desulfotomaculum) use sulfate as an electron acceptor when metabolizing carbon substrate. The metabolic reactions yield hydrogen sulfide gas and bicarbonate as end products. Hydrogen sulfide gas establishes equilibrium with bisulfide and sulfide in solution. Bicarbonate also establishes equilibrium in solution with carbonate and carbon dioxide. As a result, this process releases both hydrogen sulfide gas and carbon dioxide as well as producing aqueous phase bisulfide, sulfide, bicarbonate, and carbonate ions.

Speciation of the aqueous phase ions is pH dependent. Both carbonate and sulfide ions react with metals to produce insoluble complexes. A flocculant would be added to the reactor effluent for gravity clarification. The resultant sludge from the clarifier would be processed by a filter press. A portion of the clarifier effluent (approximately 20 percent) would be routed through MF and reverse osmosis (RO) membranes to further reduce TDS and ensure compliance with ARARs of the discharge effluent when the sidestream and main effluent are blended back together. The RO reject would be processed using mechanical evaporation. For the purpose of this FFS, the processed sludge and salt is assumed to be disposed onsite in the existing lined ponds and pads. Excess carbon dioxide and hydrogen sulfide gas produced in the anaerobic reactors would be collected and routed to a submerged fine bubble diffuser system in Strawberry Pond. These gases would establish aqueous phase equilibrium with sulfide, bisulfide, carbonate, and bicarbonate and cause some pretreatment metals removal and pH adjustment. Hydrogen sulfide gas emissions to the environment are expected to be minimal.

Alternative 5f would also include: O&M of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.13 Alternative 5g – New ARD WTP with Proprietary Microencapsulation/Precipitation, and Full Stream Membrane Filtration

Alternative 5g would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment. The new WTP would include two treatment trains, for a total treatment capacity of 375 gpm.

The micorencapsulation process consists of the addition of a silica reagent to the influent. The silica reagent encapsulates metal hydroxides through a series of pH adjustment and electrokinetic reactions. The resulting silica matrix is then precipitated in a sedimentation tank. Full stream membrane filtration would be used to reduce TDS to below the ARAR requirements. Membrane product water would be combined with the main effluent stream and discharged to the receiving waters. The membrane reject would be processed through mechanical evaporation, and, for the purpose of this FFS, the processed sludge and salts (from the evaporation unit) are assumed to be disposed onsite in the existing lined ponds and pads.

Alternative 5g would also include: operations and maintenance (O&M) of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.14 Alternative 5h – New ARD WTP with Optimized Chemical Precipitation Using Proprietary Metals Coordination Process and Full Stream Membrane Filtration

Alternative 5h would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment. The new WTP would include two identical treatment trains, for a total treatment capacity of 375 gpm.

The metals coordination process consists of the application of proprietary polymer technology to encapsulate metal contaminants and produce a settleable particulate. Chemical reagents and polymers are dosed into the influent stream to adjust pH and produce metal precipitates to an optimized size range (50 to 250 microns). The stream flows through a sedimentation tank, followed by membrane filtration (microfiltration); sludge is treated using a centrifuge and/or filter press. Full stream membrane filtration would be used to reduce TDS to below the ARAR requirements. Membrane product water would be combined with the main effluent stream and discharged to the receiving waters. The membrane reject would be processed through mechanical evaporation, and, for the purpose of this FFS, the processed sludge and salts (from the evaporation unit) are assumed to be disposed onsite in the existing lined ponds and pads.

Alternative 5h would also include: operations and maintenance (O&M) of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.15 Alternative 6a – Upgrade Existing Caustic Chemical Precipitation ARD WTP With Additional Treatment Train and Filtration (Interim ARAR Waiver)

Alternative 6a would include upgrading the existing caustic chemical precipitation WTP and the addition of another ARD treatment train for a total treatment capacity of 375 gpm. The upgrade would also include the addition of filtration. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond and from Strawberry Pond to the WTP, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment.

This alternative assumes the completion of BOR optimization upgrades prior to implementation. The additional treatment train would be identical to that of the optimized BOR process and would include conventional chemical precipitation and sludge handling. Caustic addition would continue to be used to precipitate metal hydroxides. An outdoor circular clarifier would serve as a sedimentation basin. A disc filter would follow the settling units to remove additional TSS prior to discharge to Strawberry Creek. An acid pH adjustment tank would also be provided in the event that effluent pH requires adjustment to meet the discharge limit; although pH

adjustment is not currently required to meet the discharge limit. A portion of the sludge from the clarifiers would be returned to the head of the plant, with the sludge waste stream processed using a filter press. For the purpose of this FFS, it is assumed that the processed sludge is disposed of onsite in the existing lined ponds and pits and final pH adjustment with acid is required.

Alternative 6a would also include: O&M of the upgraded ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.16 Alternative 6b – Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Addition and Upgrade With Additional Treatment Train and Filtration (Interim ARAR Waiver)

Alternative 6b would include converting the existing caustic chemical precipitation ARD WTP to a lime chemical precipitation process and the addition of another treatment train for a total treatment capacity of 375 gpm. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond and from Strawberry Pond to the WTP, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment.

Each treatment train would consist of conventional chemical precipitation and sludge handling. Lime addition would be used to precipitate metal hydroxides. An outdoor circular clarifier would serve as a sedimentation basin. A disc filter would follow the settling units to remove additional TSS prior to discharge to Strawberry Creek. An acid pH adjustment tank would also be provided in the event that effluent pH requires adjustment to meet the discharge limit; although pH adjustment is not currently required to meet the discharge limit. A portion of the sludge from the clarifiers would be returned to the head of the plant, with the sludge waste stream processed using a filter press. For the purpose of this FFS, it is assumed that the processed sludge is disposed of onsite in the existing lined ponds and pads and final pH adjustment is required.

Alternative 6b would also include: O&M of the upgraded/converted ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.17 Alternative 6c – Construct New Proprietary Microencapsulation/Precipitation ARD WTP (Interim ARAR Waiver)

Alternative 6c would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo

Gulch and Pond C seep flows for treatment. The new WTP would include two identical treatment trains with a total capacity of 375 gpm.

The train would consist of a proprietary silica microencapsulation process. A silica reagent would be added to the influent ARD stream. The reagent is used to adjust pH and react with the metal contaminants to form insoluble metal hydroxide complexes encapsulated within a silica matrix. The resulting particulate is then settled within a sedimentation tank prior to effluent discharge. Produced sludge is stored in a tank for collection and disposal by a vacuum truck. For the purpose of this FFS, the processed sludge is assumed to be disposed onsite in the existing lined ponds and pads.

Alternative 6c would also include: O&M of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.2.18 Alternative 6d - Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (Interim ARAR Waiver)

Alternative 6d would include the construction of a new ARD WTP located south of Strawberry Creek Pond. The ARD surface waters would be collected and pumped from Sunday Pit to Strawberry Pond, and Alternative 3a or 3b would collect Hoodoo Gulch and Pond C seep flows for treatment. The new WTP would include two separate identical treatment trains, each having treatment capacity for approximately half the influent flow for a total treatment capacity of 375 gpm.

Each train would consist of a proprietary optimized chemical precipitation process. Hydroxide addition would be used to adjust the pH of the influent stream. A proprietary process using metals coordination would be implemented through the addition of commercially available chemicals and a proprietary chemical additive to form insoluble metal complexes. A sedimentation basin would follow for settling of the complexes. MF would be used to further remove remaining complexes. The sludge waste stream is processed using a filter press. For the purpose of this FFS, the processed sludge is assumed to be disposed onsite in the existing lined ponds and pads. The potential exists to recycle the metals contained in the sludge waste stream.

Alternative 6d would also include: O&M of the new ARD WTP and the ARD collection and transmission systems (excluding pump operating costs associated with Alternative 3), and administrative costs associated with the WTP, including snow removal, temporary laboratory facilities, vehicles, utilities, and other direct costs.

5.3 Initial Screening of Alternatives

The objective of initial alternative screening is to eliminate those alternatives found to be ineffective, not implementable, and/or prohibitively costly. Each of the alternatives were either rejected or retained for further consideration in the detailed analysis of alternatives. Initial/baseline alternative screening was based on effectiveness,

implementability, and comparative costs as discussed in paragraph 4.2.1. Capital and O&M costs developed for each alternative are presented in Appendix B.

The following sections present the initial screening of the alternatives.

5.3.1 Alternative 1 – No Action

5.3.1.1 Effectiveness

Under the no action alternative, no treatment action would be taken to reduce toxicity, mobility, or volume of ARD. This alternative would fail to achieve the IRAOs for ARD. However, the no action alternative is required by the NCP to be carried through the screening process to provide a baseline for comparison of remedial alternatives.

5.3.1.2 Implementability

This alternative is ranked as highly implementable.

5.3.1.3 Cost

The cost associated with the no action alternative is for surface water monitoring and preparation of 5-year review site reports, and is expected to be very low in comparison with other alternatives.

5.3.1.4 Screening Comment

This alternative was retained for detailed analysis in accordance with the NCP.

5.3.2 Alternative 2 – Continue Treatment of ARD with Existing ARD WTP, and Pond C and Hoodoo Gulch Hydroxide Bucket Method

5.3.2.1 Effectiveness

Collection of ARD at the Site includes the transfer of ARD from several different storage ponds to Sunday Pit. Flow to the existing WTP is first routed from these storage pits to Strawberry Pond, and from Strawberry Pond to the ARD WTP via pumps. Diversion structures are used to keep clean surface water from entering the Site and becoming contaminated. The existing ARD WTP, left over from the private operation of the mine, has been shown to be undersized and the processes difficult to operate. The processes are currently being evaluated by the BOR, under EPA emergency response funds, in order to optimize treatment capacity at a flow rate of 300 gpm. Sludge management practices are also being modified. Anticipated results include an increase in removal efficiencies for contaminants of concern (COCs) and more consistent influent ARD water quality that will increase the treatment efficiency of the WTP. The NaOH bucket treatment systems currently treating Hoodoo Gulch and Pond C seep flows are only moderately effective and have a high potential for untreated ARD release into local surface waters. This alternative is rated as moderate in effectiveness.

5.3.2.2 Implementability

Source water collection and treatment measures already being implemented at the Site would continue, as would bucket treatment of ARD from Pond C and Hoodoo Gulch seeps. Sludge disposal would be necessary at a location onsite. This alternative would rank high in implementation.

5.3.2.3 Cost

The cost associated with this alternative is considered to be high. The current O&M costs average approximately $3 million per year.

5.3.2.4 Screening Comment

This alternative is not retained for detailed analysis. The effectiveness is moderate and O&M costs are high.

5.3.3 Alternative 3a – Divert ARD Seep Flows from Hoodoo Gulch to Sunday Pit; Divert Pond C ARD Seep Flows to Pond D

5.3.3.1 Effectiveness

Collection and treatment of ARD at the Site would be augmented by the diversion of Hoodoo Gulch ARD seep flows to Sunday Pit and Pond C ARD seep flows to Pond D. This alternative would remove the unreliable bucket treatment systems currently used at Hoodoo Gulch and Pond C and decrease the potential for a release of untreated ARD to Strawberry Creek. The Hoodoo Gulch ARD seep flows would be collected in sumps and routed to a storage tank upstream of Strawberry Creek. From the storage tank, the collected ARD would be pumped to Sunday Pit. The Pond C ARD seep flows would be intercepted as surface water run off in a HDPE lined channel located to the east of Pond C. The channel would flow to the south with discharge to Pond D. This alternative is rated as highly effective.

This alternative would be selected along with Alternative 4, 5, or 6. The ARD would be collectively treated at the existing ARD WTP or a new WTP, prior to discharge to Strawberry Creek.

5.3.3.2 Implementability

This alternative would require:

- Construction of an HDPE lined channel
- Seep collection sumps
- Storage tank
- A submersible pump
- Pipeline from the storage tank to Sunday Pit

Conventional equipment and materials would be used to complete the construction. This alternative would rank high in implementation.

5.3.3.3 Cost

The cost associated with this alternative is very low.

5.3.3.4 Screening Comment

This alternative is retained for detailed analysis.

5.3.4 Alternative 3b – Divert ARD Seep Flows from Hoodoo Gulch to Strawberry Pond; Divert Pond C ARD Seep Flows to Pond D

5.3.4.1 Effectiveness

Collection and treatment of ARD at the Site would be augmented by the diversion of Hoodoo Gulch ARD seep flows to Strawberry Pond and Pond C seep flows to Pond D. This alternative would remove the unreliable bucket treatment systems currently used at Hoodoo Gulch and Pond C and decrease the potential for a release of untreated ARD to Strawberry Creek. The ARD seep flows from Hoodoo Gulch would be collected in sumps and routed to a storage tank upstream of Strawberry Creek. From the storage tank, the collected ARD would be pumped to Strawberry Pond. The Pond C ARD seep flows would be intercepted as surface water run off in a HDPE lined channel located to the east of Pond C. The channel would flow to the south with discharge to Pond D. This alternative is rated as highly effective.

This alternative would be selected along with Alternative 4, 5, or 6. The ARD would be collectively treated at the existing ARD WTP or a new WTP, prior to discharge to Strawberry Creek.

5.3.4.2 Implementability

This alternative would require:

- Construction of an HDPE lined channel
- Seep collection sumps
- Storage tank
- A submersible pump
- Pipeline from the storage tank to Strawberry Pond

Conventional equipment and materials would be used to complete the construction. This alternative would rank high in implementability.

5.3.4.3 Cost

The cost associated with this alternative is very low.

5.3.4.4 Screening Comment

This alternative is retained for detailed analysis.

5.3.5 Alternative 4a – Follow Existing Chemical Precipitation with Full Stream Membrane Filtration

5.3.5.1 Effectiveness

This alternative includes upgrades to the existing ARD WTP consisting of acid pH adjustment, MF and NF membrane units, and a mechanical evaporator, as described

previously, for a total treatment capacity of approximately 300 gpm. The MF membrane would protect the NF membrane from fouling due to TSS (metal precipitates) not removed in the lamella plate clarifier. The primary role of the NF membrane would be to reduce TDS concentrations. The MF membrane reject would be returned back to the head of the plant for mixing with the influent as seeding solution and for additional precipitation. Reject from the NF would be processed through the mechanical evaporation unit.

Membranes by themselves and in conjunction with pretreatment have been shown to be effective barriers to TDS, microbes, metals, and organic compounds (AWWA 1990). They are widely used in industrial and municipal applications for the purification of source waters. This treatment train would provide the necessary removal mechanisms to reduce metals (including selenium) and TDS concentrations below ARAR limits. However, pilot testing is necessary to determine the most effective membrane material and pore size as well as the optimum chemical feed doses. This alternative is rated as high in effectiveness.

5.3.5.2 Implementability

Implementation of this alternative would require:

- A new building to house the upgrade process equipment
- Associated piping and pumping systems
- Chemical feed systems
- MF and NF membrane systems
- Evaporation system
- Additional sludge handling and dewatering facilities
- Pilot testing of the process

There are numerous manufacturers and types of membranes commercially available. Polymers, cellulose acetate, and thin film composites are the oft-used materials for membranes. Another membrane option is a ceramic MF membrane that has been pilot tested at the Site. The ceramic membrane system can operate at lower pH conditions than other membranes and has been shown to reduce heavy metal concentrations below detection limits when used in conjunction with chemical addition, although it has not been demonstrated in a long-term full scale application. A NF unit would still be required to maintain TDS and selenium compliance.

Sludge management would consist of disposing the sludge residuals (both cake and salts) at an onsite location.

This alternative would rank high in implementability.

5.3.5.3 Cost

The cost associated with this alternative is high.

5.3.5.4 Screening Comment

This alternative is not retained for detailed analysis due to the high cost of implementation and operations during the interim Site closure activities.

5.3.6 Alternative 4b – Replace Existing Sodium Hydroxide Chemical Precipitation with Lime Addition, Proprietary Sulfate Removal Process, and pH Adjustment

5.3.6.1 Effectiveness

This alternative would replace the existing NaOH chemical precipitation with lime addition and proprietary sulfate removal process for a total treatment capacity of 300 gpm. Chemical precipitation is widely used for the removal of heavy metals from wastewater. Implementing this alternative would require extensive pilot-testing to assert the removal efficiency for both heavy metals and TDS. The proprietary sulfate removal process removes sulfate at a high pH, requiring increased doses of lime. It is unknown whether this process would remove TDS below ARAR limits. Sludge management would consist of disposing the sludge residuals (both cake and salts) at an onsite location. This alternative is rated as moderate in effectiveness.

5.3.6.2 Implementability

This alternative would include:

- A new building to house additional process equipment
- Associated piping systems
- Installation of a lime feed system
- Installation of proprietary process reaction tanks and chemical feed system
- A carbon dioxide feed system (or other pH adjustment chemical feed system
- Additional sludge handling and dewatering facilities
- Pilot testing of the process

Implementability of this alternative would be ranked moderate due to the proprietary nature of the process and the extensive pilot-study requirements.

5.3.6.3 Cost

The compound used in the proprietary sulfate removal process is supplied by a single representative within the United States; the chemical costs are comparatively high (estimated at $1.3 million/year; [Carmen 2000]). Overall, costs associated with this alternative are estimated to be very high.

5.3.6.4 Screening Comment

This alternative is not included in the detailed analysis because the removal efficiency for TDS is unknown and implementability is only moderate due to extensive pilot testing requirements and the proprietary nature of the process. Additionally, the proprietary process is cost prohibitive and not required since membrane filtration will control TDS concentrations at less cost.

5.3.7 Alternative 5a – New ARD WTP with Caustic Addition, Chemical Precipitation, and Full Stream Membrane Filtration

5.3.7.1 Effectiveness

This alternative would implement chemical precipitation and MF and NF membrane filtration at a treatment capacity of 375 gpm; the treatment rate, as presented in paragraph 2.7.1, is based on the Site water balance. The MF membrane would protect the NF membrane from fouling due to TSS (metal precipitates) not removed in the circular clarifier. The primary role of the NF membrane would be to reduce TDS and selenium concentrations. The MF membrane reject would be routed back to the head of the plant to be blended with influent as a seeding solution for additional precipitation. Reject from the NF would be processed through the mechanical evaporation unit. Sludge management would consist of disposing the sludge residuals (both cake and salts) at an onsite location.

Membranes have been shown to be effective barriers to TDS, microbes, metals, and organic compounds. They are widely used in industrial and municipal applications for the purification of source waters. This treatment train would provide the necessary removal mechanisms to reduce metals (including selenium) and TDS concentrations below ARAR limits. However, pilot testing is necessary to determine the most effective membrane material and pore size as well as the optimum chemical feed doses. This alternative is rated high in effectiveness.

5.3.7.2 Implementability

Implementation of this alternative would require:

- Construction of a new ARD WTP south of Strawberry Pond
- Installation of two chemical precipitation treatment trains
- Installation of MF and NF systems
- Installation of associated piping and pumping systems
- Installation of chemical feed systems
- Evaporation system
- Installation of a sludge handling and dewatering facilities
- Pilot testing of the process

There are numerous manufacturers and types of membranes commercially available. Polymers, cellulose acetate, and thin film composites are the oft-used materials for membranes. Another membrane option is a ceramic MF membrane that has been pilot tested at the Site. The ceramic membrane system can operate at lower pH conditions than other membranes and has been shown to reduce heavy metal concentrations in conjunction with chemical addition to below detection limits. A NF unit would be required to maintain TDS compliance.

This alternative would rank high in implementability.

5.3.7.3 Cost

The cost associated with this alternative is very high.

5.3.7.4 Screening Comment

This alternative is not retained for detailed analysis due to high costs associated with construction of a new treatment plant and annual O&M.

5.3.8 Alternative 5b – New ARD WTP with Lime Addition, Chemical Precipitation, and Partial Stream Membrane Filtration

5.3.8.1 Effectiveness

This alternative would implement chemical precipitation and partial stream (approximately 50 percent) MF and NF membrane filtration at a treatment capacity of 375 gpm. The MF membrane would protect the NF membrane from fouling due to TSS (metal precipitates) not removed in the circular clarifier. The primary role of the NF membrane would be to reduce TDS and selenium concentrations. The MF membrane reject would be routed back to the head of the plant to be blended with influent as a seeding solution for additional precipitation. Reject from the NF would be processed through the mechanical evaporation unit. Sludge management would consist of disposing the sludge residuals (both cake and salts) at an onsite location. Membranes have been shown to be effective barriers to TDS, microbes, metals, and organic compounds. They are widely used in industrial and municipal applications for the purification of source waters. This treatment train would provide the necessary removal mechanisms to reduce heavy metal and concentrations below ARAR limits. However, pilot testing is necessary to determine the most effective membrane material and pore size as well as the optimum chemical feed doses. This alternative is rated high in effectiveness.

5.3.8.2 Implementability

Implementation of this alternative would require:

- Construction of a new ARD WTP south of Strawberry Pond
- Installation of two chemical precipitation treatment trains
- Installation of MF and NF systems
- Installation of associated piping and pumping systems
- Installation of chemical feed systems
- Evaporation system
- Installation of a sludge handling and dewatering facilities
- Pilot testing of the process

There are numerous manufacturers and types of membranes commercially available. Polymers, cellulose acetate, and thin film composites are the oft-used materials for membranes. Another membrane option is ceramic MF membrane that has been pilot tested at the Site. The ceramic membrane system can operate at lower pH conditions than other membranes and has been shown to reduce heavy metal concentrations below detection limits. A NF unit would be required to maintain TDS compliance.

This alternative would rank high in implementability.

5.3.8.3 Cost

The cost associated with this alternative is very high.

5.3.8.4 Screening Comment

This alternative is not retained for detailed analysis due to high costs associated with construction of a new treatment plant and annual O&M.

5.3.9 Alternative 5c – New ARD WTP Including Lime Addition, Chemical Precipitation, Proprietary Sulfate Removal Process, and pH Adjustment

5.3.9.1 Effectiveness

This alternative would implement lime addition chemical precipitation and a proprietary sulfate removal process in a new ARD WTP at a treatment capacity of 375 gpm. Chemical precipitation is widely used for the removal of heavy metals from wastewater. Implementing this alternative would require extensive pilot-testing to assert the removal efficiency for both heavy metals and TDS. The proprietary sulfate removal process removes sulfate at a high pH, requiring increased doses of lime. It is unknown whether this process would remove TDS below ARAR limits. Sludge management would consist of disposing the sludge at an onsite location. This alternative is rated moderate in effectiveness.

5.3.9.2 Implementability

This alternative would include:

- Construction of a new ARD WTP south of Strawberry Pond
- Installation of hydroxide precipitation and proprietary process reaction tanks
- A carbon dioxide feed system (or other pH adjustment chemical feed system)
- Piping and pumping systems
- Chemical feed systems
- Sludge handling and dewatering facilities
- Pilot testing of system

Implementability of this alternative would be ranked moderate.

5.3.9.3 Cost

The compound used in the proprietary process is supplied by a single representative within the United States; the chemical costs are prohibitively high (estimated at $1.3 million/year; [Carmen 2000]). Overall, costs associated with this alternative are estimated to be very high.

5.3.9.4 Screening Comment

This alternative is not retained for analysis because the removal efficiency for TDS is unknown and implementability is moderate due to extensive pilot testing and the proprietary nature of the process. Finally, the proprietary process is costly and not required since membrane filtration will control TDS concentrations at less cost.

5.3.10 Alternative 5d — New ARD WTP with Ion Exchange, Partial Stream Membrane Filtration, and pH Adjustment

5.3.10.1 Effectiveness

This alternative would implement an IX and partial stream MF and NF membrane filtration process in a new ARD WTP at a treatment capacity of 375 gpm. IX is an effective treatment option for removal of specific metals. Particular resins would be required to remove the target metals observed in the waste stream. As such, a series of units would be required to comply with the ARARs. IX is usually not feasible with high TDS levels (AWWA 1990). Pretreatment processes would also be required to maintain influent water quality for optimal IX performance. Due to the high concentrations of contaminants, it would be necessary to constantly regenerate the IX resin, resulting in additional chemical usage and waste handling requirements. Sludge management would consist of disposing the sludge residuals (both cake and salts) at an onsite location. Extensive pilot testing would be required to ascertain the effectiveness of contaminant removal. Therefore, this alternative is rated low in effectiveness.

5.3.10.2 Implementability

This alternative would require:

- Construction of a new ARD WTP south of Strawberry Pond
- Two IX treatment trains
- Piping and pumping systems
- Regenerant systems
- MF and NF membrane systems
- An evaporation unit
- IX regeneration
- Extensive pilot testing of the process

Implementation of this alternative is ranked low because of the specialty nature of IX treatment trains and required pilot-study.

5.3.10.3 Cost

The cost associated with this alternative is very high.

5.3.10.4 Screening Comment

This alternative is not retained for analysis because of the unfeasibility of treating waste streams with high TDS concentrations using IX. Although a pretreatment for TDS could be added, it increases operational complexity and already very high costs.

5.3.11 Alternative 5e – New ARD WTP Including Electrocoagulation and Partial Stream Membrane Filtration

5.3.11.1 Effectiveness

This alternative would implement an EC and partial stream MF and NF membrane filtration process in a new WTP at a treatment capacity of 375 gpm. The EC process is

being researched for implementation with ARD. EC is an effective treatment for the removal of metals although it is unknown whether TDS would be effectively controlled. The EC process does not remove sulfate very well (Herbst 2000). Sludge management would consist of disposing the sludge residuals (both cake and salts) at an onsite location. Effectiveness is rated as low.

5.3.11.2 Implementability

This alternative would require:

- Construction of a new ARD WTP south of Strawberry Pond
- Two electrocoagulation treatment trains
- Piping and pumping systems
- MF and NF membrane systems
- Evaporation unit
- Sludge handling and dewatering facilities
- Pilot testing of the process

Implementability of this alternative would be ranked low due to the extensive pilot-study that would be required and specialty nature of the treatment process.

5.3.11.3 Cost

The cost associated with this alternative is high.

5.3.11.4 Screening Comment

This technology may offer a cheaper alternative to conventional chemical precipitation, but would require extensive pilot testing for application to ARD treatment. This alternative is not retained for analysis because the efficiency for sulfate and TDS removal is unknown, and full-scale applications to ARD treatment have not been identified.

5.3.12 Alternative 5f –New ARD WTP Including Anaerobic Sulfate Reduction, Metal Sulfide/Carbonate Precipitation, and Partial Stream Membrane Filtration

5.3.12.1 Effectiveness

This alternative would implement an anaerobic sulfate reducing bioreactor and partial stream MF and RO filtration process in a new ARD WTP at a capacity of 375 gpm. Anaerobic processes can theoretically be used to precipitate metal complexes from wastewater. Sulfate-reducing bacteria (Desulfovibrio and Desulfotomaculum) use sulfate as an electron acceptor when metabolizing carbon substrate. The metabolic reactions yield hydrogen sulfide gas and bicarbonate as end products. Hydrogen sulfide gas establishes equilibrium with bisulfide and sulfide in solution. Bicarbonate also establishes equilibrium in solution with carbonate and carbon dioxide. As a result, this process releases both hydrogen sulfide gas and carbon dioxide as well as producing aqueous phase bisulfide, sulfide, bicarbonate, and carbonate ions. The speciation of the aqueous ions is pH dependent. Both

carbonate and sulfide ions react with metals to produce insoluble complexes. As a result, metals are removed from the waste stream.

Both the metals precipitation and the off gassing reduce TDS in the waste stream. However, it is anticipated that the TDS reduction achieved will not meet the ARARs. Therefore, partial stream membrane filtration is included to reduce overall TDS. Prior to membrane filtration, the pH would be adjusted down to reduce calcium carbonate scaling potential on the membranes. The filtered stream would be blended with the unfiltered stream prior to discharge to maintain effluent TDS concentrations below ARAR levels.

Excess carbon dioxide and hydrogen sulfide gas produced in the anaerobic reactors would be collected and routed to a submerged coarse bubble diffuser system in Strawberry Pond. These gases would establish aqueous phase equilibrium with sulfide, bisulfide, carbonate, and bicarbonate and cause some pretreatment metals removal and pH adjustment. Hydrogen sulfide gas emissions to the environment are expected to be minimal.

Sludge management would consist of disposing the sludge residuals (both cake and salts) at an onsite location.

The operation of this technology is dependent upon water quality parameters (e.g., pH, metals concentrations, temperature). The application of this process to ARD treatment at the Site would require extensive pilot testing to ascertain the removal efficiency of both metals and TDS, and to determine bioreactor design parameters (i.e., biological kinetics, off-gassing volumes, reaction rates, etc.). Therefore, this alternative is rated moderately effective.

5.3.12.2 Implementability

This alternative would require:

- The construction of a new ARD WTP south of Strawberry Pond
- Anaerobic reactors
- MF and RO membrane systems
- Chemical feed systems
- Piping and pumping systems
- Evaporation units
- A sludge press
- Gas collection, compressor, and fine bubble diffuser system
- Pilot testing of the process

Implementability of this alternative is rated moderate due to the pilot-study requirements and the expected large footprint of the processes.

5.3.12.3 Cost

The cost associated with this alternative is very high.

5.3.12.4 Screening Comment

This alternative is not retained for detailed analysis due to extensive pilot test requirements and high capital and O&M costs.

5.3.13 Alternative 5g – New ARD WTP with Proprietary Microencapsulation/Precipitation, and Full Stream Membrane Filtration

5.3.13.1 Effectiveness

This alternative would implement a proprietary precipitation process utilizing a calcium- and silica-based chemical reagent that adjusts pH and encapsulates metal hydroxides within a silica matrix. The microencapsulation process produces a sand-like particulate that is easily settled; applications to treatment of ARD and other metal-laden waste streams have shown the process to meet requirements for the removal of metals prior to discharge to receiving waters. Full stream MF and NF membrane filtration processes would be used to meet TDS requirements.

The system would have a total design capacity of 375 gpm. A process train has been pilot-tested on the ARD at the Site; results were inconclusive due to unforeseen operational and weather conditions. The potential for this process to successfully reduce metal concentrations below ARAR levels and produce a stable sludge that meets TCLP requirements may be demonstrated through further pilot testing. Sulfate concentrations may also be reduced, resulting in additional reduction of TDS. The effectiveness of microencapsulation for the removal of TDS would be determined by pilot testing. For the purposes of this FFS, sludge management would consist of disposing the sludge residuals at an onsite location.

The process includes the addition of one of a range of proprietary calcium/silica chemical reagents that adjust pH to a target level that provides for the removal of the contaminants. The operation of this technology is dependent upon water quality parameters (e.g., pH, metals concentrations) and is flexible in response to changing ARD water quality parameters. The application of this process to ARD treatment at the Site would require additional pilot testing to ascertain the removal efficiency of both metals and TDS, as well as other discharge requirements. The process has been used in other ARD treatment applications.

This alternative is considered moderately effective for ARD treatment.

5.3.13.2 Implementability

This alternative would require:

- The construction of a new ARD WTP south of Strawberry Pond
- Installation of two treatment trains for redundancy
- Proprietary chemical feed systems
- Proprietary chemical reagents
- Piping and pumping systems
- MF and NF membrane systems

- Evaporation unit
- Sludge handling and dewatering facilities
- Pilot testing

Implementability of this alternative is rated moderate. The proprietary chemical reagents are currently supplied by one company, possibly limiting the availability of competitive bid pricing.

5.3.13.3 Cost

The cost associated with this alternative is high.

5.3.13.4 Screening Comment

This alternative is not retained for detailed analysis due to moderate implementability as a result of the extensive pilot testing requirements and proprietary nature of the process as well as the high capital and O&M costs.

5.3.14 Alternative 5h – New ARD WTP with Optimized Chemical Precipitation Using Proprietary Metals Coordination Process and Full Stream Membrane Filtration

5.3.14.1 Effectiveness

This alternative would implement proprietary optimized chemical precipitation/ metals coordination and MF membrane filtration process in a new ARD WTP at a capacity of 375 gpm. Full stream NF membrane filtration would be used to meet TDS requirements. A proprietary process using metals coordination has been pilot-tested on the ARD at the Site and shown to be effective in metals removal. Metal concentrations have been shown to be reduced below ARAR levels, with some removal of TDS. The expected TDS removal is not sufficient to reduce concentrations below the ARAR limit, but the enhanced removal of metals using this process was indicative of its potential for treating ARD. For the purposes of this FFS, sludge management would consist of disposing the sludge residuals at an onsite location. The potential exists for the sludge residuals to be recycled.

The process includes the addition of both commercially available chemicals (hydroxide for pH adjustment) and proprietary polymers that enhance the complexation of target contaminants. The implementation of this chemical process can not be independently verified without a non-disclosure agreement with the process engineers. Additional pilot-study would be required to characterize the treatability of the ARD within ARAR limits.

The operation of this technology is dependent upon water quality parameters (e.g., pH, metals concentrations) and is flexible enough to be adjusted for changing ARD water quality parameters. The application of this process to ARD treatment at the Site would require additional pilot testing to ascertain the removal efficiency of both metals and TDS, as well as other discharge requirements. This process has been used in other ARD treatment applications, providing up to 4,000 gpm of treatment capacity.

This alternative is considered highly effective, requiring additional pilot-study.

5.3.14.2 Implementability

This alternative would require:

- The construction of a new ARD WTP south of Strawberry Pond
- Chemical feed systems and redundant treatment capacity
- Proprietary engineering design and services
- Piping and pumping systems
- MF and NF membrane systems
- Evaporation unit
- Sludge handling and dewatering facilities
- Pilot testing

Implementability of this alternative is rated moderate.

5.3.14.3 Cost

The cost associated with this alternative is high.

5.3.14.4 Screening Comment

This alternative is not retained for detailed analysis due to high cost.

5.3.15 Alternative 6a – Upgrade Existing Caustic Chemical Precipitation ARD WTP With Additional Treatment Train and Filtration (Interim ARAR Waiver)

5.3.15.1 Effectiveness

This alternative would continue using a chemical precipitation process with caustic addition for metals removal and pH adjustment only in the upgraded existing ARD WTP at a treatment capacity of 375 gpm (upgrades include an additional treatment train to increase treatment capacity and post sedimentation filtration). Chemical addition using caustic to precipitate metal hydroxides has been widely used in ARD treatment applications. This process has been shown to reduce metal concentrations to below ARAR limits; many of the technologies described in the preceding sections enhance precipitation of contaminants. TDS removal due to metals precipitation will be partially offset by the addition of sodium and is not anticipated to meet the ARAR limit. Additionally, selenium removal by the precipitation process is not anticipated to meet the ARAR limit. Sludge management would consist of disposing of the dewatered sludge residuals at an onsite location.

This alternative is considered highly effective with an interim ARAR waiver of the TDS and selenium water quality standards or establishment of a higher TDS limit based on the results of the ecological risk assessment. Additional measures to remove TDS and selenium could be implemented as needed if interim waivers of select ARARs (i.e., TDS and selenium) are not obtained.

5.3.15.2 Implementability

This alternative would require:

- The construction of an additional treatment train adjacent to the existing ARD WTP
- Construction of a new building to house the additional treatment train, filtration equipment, and sludge handling equipment
- Associated chemical feed systems
- Associated piping and pumping systems
- A disc filter and filter press
- Pilot plant and limited pilot testing

Implementability of this alternative would be ranked high.

5.3.15.3 Cost

The cost associated with this alternative is moderate.

5.3.15.4 Screening Comment

This alternative is retained for detailed analysis based on the wide application of caustic soda pH adjustment and metals precipitation for ARD treatment and the moderate costs.

5.3.16 Alternative 6b – Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Addition and Upgrade With Additional Treatment Train and Filtration (Interim ARAR Waiver)

5.3.16.1 Effectiveness

This alternative would convert and upgrade the existing caustic chemical precipitation ARD WTP to a lime chemical precipitation process for metals removal and pH adjustment only. Conversion consists of adding a lime slaking and slurry feed system and minor piping modifications. Upgrades include the addition of another lime treatment train and post sedimentation filtration for a total treatment capacity of 375 gpm. Chemical addition using lime to precipitate metal hydroxides has been widely used in ARD treatment applications. This process has been shown to reduce metal concentrations to below ARAR limits. It is anticipated that TDS concentrations will be reduced through the precipitation of calcium sulfate (gypsum). However, it is uncertain if TDS will be reduced below the ARAR limit. Additionally, it is unknown whether selenium will be reduced below the ARAR limit. The sludge production from this process is expected to be about twice the sludge produced by caustic addition, resulting in higher disposal costs. Sludge management would consist of disposing the sludge residuals at an onsite location.

This alternative is considered highly effective with an interim ARAR waiver of the TDS and selenium water quality standards or establishment of a higher TDS limit based on the results of the ecological risk assessment. Additional measures to remove TDS and selenium could be implemented as needed if interim waivers of select ARARs (i.e., TDS and selenium) are not obtained.

5.3.16.2 Implementability

This alternative would require:

- The conversion of the existing ARD WTP to lime addition
- The construction of an additional lime treatment train
- Chemical feed systems
- Piping and pumping systems
- A disc filter and filter press
- Pilot plant and limited pilot testing

Implementability of this alternative is rated high.

5.3.16.3 Cost

The cost associated with this alternative is moderate.

5.3.16.4 Screening Comment

This alternative is retained for detailed analysis based on the wide application of lime-addition pH adjustment and metals precipitation for ARD treatment and the moderate costs.

5.3.17 Alternative 6c – Construct New Proprietary Microencapsulation/Precipitation ARD WTP (Interim ARAR Waiver)

5.3.17.1 Effectiveness

This alternative would implement a proprietary precipitation process utilizing a calcium- and silica-based chemical reagent that adjusts pH and encapsulates metal hydroxides within a silica matrix. The microencapsulation process produces a sand-like particulate that is easily settled; applications to treatment of ARD and other metal-laden waste streams have shown the process to meet requirements for the removal of metals prior to discharge to receiving waters.

The system would have a total design capacity of 375 gpm. A process train has been pilot-tested on the ARD at the Site; results were inconclusive due to unforeseen operational and weather conditions. The potential for this process to successfully reduce metal concentrations below ARAR levels and produce a stable sludge that meets TCLP requirements may be demonstrated through further pilot testing. Sulfate concentrations may also be reduced, resulting in additional reduction of TDS. Selenium has also been shown to be removed by microencapsulation. The effectiveness of microencapsulation for the removal of TDS and selenium would be

determined by pilot testing. For the purposes of this FFS, sludge management would consist of disposing the sludge residuals at an onsite location.

The process includes the addition of one of a range of proprietary calcium/silica chemical reagents that adjust pH to a target level that provides for the removal of the contaminants. The operation of this technology is dependent upon water quality parameters (e.g., pH, metals concentrations) and is flexible in response to changing ARD water quality parameters. The application of this process to ARD treatment at the Site would require additional pilot testing to ascertain the removal efficiency of both metals and TDS, as well as other discharge requirements. The process has been used in other ARD treatment applications.

This alternative is considered moderately effective, requiring additional pilot-study and an ARAR waiver of the TDS and selenium water quality standards or establishment of a higher TDS limit based on the results of the ecological risk assessment. Additional measures to remove TDS and selenium could be implemented as needed if interim waivers of select ARARs (i.e., TDS and selenium) are not obtained.

5.3.17.2 Implementability

This alternative would require:

- The construction of a new ARD WTP south of Strawberry Pond
- Installation of two treatment trains for redundancy
- Proprietary chemical feed systems
- Proprietary chemical reagents
- Piping and pumping systems
- Sludge handling equipment
- Pilot testing

Implementability of this alternative is rated moderate. The chemical reagents are known to be supplied by one company, possibly limiting the availability of competitive bid pricing.

5.3.17.3 Cost

The cost associated with this alternative is moderate.

5.3.17.4 Screening Comment

This alternative is retained for detailed analysis based on moderate costs and potential for ARD treatment within the constraints of the ARARs and waivers for TDS and selenium.

5.3.18 Alternative 6d - Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (Interim ARAR Waiver)

5.3.18.1 Effectiveness

This alternative would implement proprietary optimized chemical precipitation/ metals coordination and MF membrane filtration process in a new WTP at a capacity of 375 gpm. A proprietary process using metals coordination has been pilot-tested on the ARD at the Site and shown to be effective in metals removal. Metal concentrations (including selenium) have been shown to be effectively reduced below ARAR levels, with some removal of TDS. The expected TDS removal is not sufficient to reduce concentrations below the ARAR limit, but the enhanced removal of metals using this process was indicative of its potential for treating ARD. For the purposes of this FFS, sludge management would consist of disposing the sludge residuals at an onsite location. The potential exists for the sludge residuals to be recycled.

The process includes the addition of both commercially available chemicals (hydroxide for pH adjustment) and proprietary polymers that enhance the complexation of target contaminants. The implementation of this chemical process can not be independently verified without a non-disclosure agreement with the process engineers.

The operation of this technology is dependent upon water quality parameters (e.g., pH, metals concentrations) and is flexible enough to be adjusted for changing ARD water quality parameters. The application of this process to ARD treatment at the Site would require additional pilot testing to ascertain the removal efficiency of both metals and TDS, as well as other discharge requirements. This process has been used in other ARD treatment applications, providing up to 4,000 gpm of treatment capacity.

This alternative is considered highly effective with an ARAR waiver of the TDS water quality standards or establishment of a higher TDS limit based on the results of the ecological risk assessment. Additional measures to remove TDS could be implemented as needed if interim waivers of select ARARs (i.e., TDS) are not obtained.

5.3.18.2 Implementability

This alternative would require:

- The construction of a new WTP south of Strawberry Pond
- Chemical feed systems and redundant treatment capacity
- Proprietary engineering design and services
- Piping and pumping systems
- A filter press
- Pilot testing

Implementability of this alternative is rated moderate. However, the proprietary nature of the treatment technology limits the availability of expertise and competitive bid pricing.

5.3.18.3 Cost

The cost associated with this alternative is moderate.

5.3.18.4 Screening Comment

This alternative is retained for detailed analysis based on moderate costs and potential for ARD treatment within the constraints of the ARARs and waivers for TDS and selenium.

5.4 Summary of Alternatives Screening

Each alternative developed and described in paragraph 5.2 was evaluated to determine its overall effectiveness, implementability, and cost in paragraph 5.3. These criteria for evaluation are similar to those previously used to evaluate the process options, as defined in paragraph 4.3. Table 5-1 summarizes the results for the screening of alternatives for the interim Gilt Edge ARD treatment action.

It was noted during the development of the conceptual costs that offsite hazardous waste disposal of process sludge is a very significant O&M cost. Due to the high costs for offsite disposal and the very high potential to dispose of the sludge onsite in some of the existing lined ponds and pads, the alternatives retained for detailed analysis in Sections 6 and 7 will be analyzed using onsite disposal costs. Should this assumption not prove feasible because of regulatory or other site closure issues, additional costs for offsite disposal will be incurred, increasing the annual O&M expenditures. This could impact the analysis of alternatives presented in this feasibility study and selection of the interim ARD treatment action. For example, the estimated costs for sludge disposal at an offsite disposal facility were calculated using the conservative assumption that it would require hazardous waste disposal because the sludge would not pass a TCLP analysis. Sludge disposal costs are estimated to range from $621,000 per year (Alternative 6a; approximately 12 percent of annual costs) to $1,241,000 per year (Alternative 6b; approximately 26 percent of annual costs); the average for all alternatives was an additional $913,000 per year. On a comparison basis, the conceptual cost for the disposal of the sludge and other residuals at a non-hazardous landfill is approximately 60 percent of the landfill costs described above.

Treatment Alternatives 4 and 5 presented in this section address complete compliance with the ARAR requirements identified in Section 3, while those alternatives listed under Alternative 6 do not necessarily comply with the TDS and selenium ARARs. For those technologies identified to meet the regulatory requirements, the screening costs indicate that compliance will incur high costs for the interim action. The addition of TDS and selenium control using membrane filtration was observed to significantly increase the developed conceptual level costs. The impact of the TDS and selenium controls is noticeable when the alternatives that do not include these controls are evaluated.

Table 5-1 Summary of Alternatives Screening

Alt.	Description	Effect.	Implement.	Cost	Capital Cost	Annual O&M Cost	Retained for Analysis?	Screening Comment
1	No Action	Low	High	Low		$220,000	Yes	Included per NCP
2	Continue Treatment of ARD with Existing WTP, and Pond C and Hoodoo Gulch Hydroxide Bucket Method (250 gpm)	Moderate	High	High	$0	$3,000,000	No	*Will not meet site discharge ARARs*
3a	Divert ARD Flow from Hoodoo Gulch to Sunday Pit (with Alternative 4 or 5)	High	High	Low	$262,000	$1,900	Yes	Convey ARD to WTP
3b	Divert ARD Flow from Hoodoo Gulch to Strawberry Pond (with Alternative 4 or 5)	High	High	Low	$307,000	$1,900	Yes	Convey ARD to WTP
4a	Follow Existing Caustic Addition and Chemical Precipitation with Membrane Filtration (300 gpm)	High	High	High	$6,624,000	$5,228,000	No	Effective treatment for removal of metals and TDS; *high cost*
4b	Replace Existing NaOH Chemical Precipitation with Lime Addition, Proprietary Sulfate Removal Process, and pH Adjustment (300 gpm)	Moderate	Moderate	Very High	Not calculated	Not calculated	No	Removal efficiency of TDS unknown; *high cost*
5a	New ARD WTP with Caustic Addition, Chemical Precipitation, and Full Stream Membrane Filtration (375 gpm)	High	High	Very High	$9,295,000	$5,858,000	No	Effective treatment for removal of metals and TDS; *high cost*
5b	New ARD WTP with Lime Addition, Chemical Precipitation, and Partial Stream Membrane Filtration (375 gpm)	High	High	Very High	$7,894,000	$3,835,000	No	Effective treatment for removal of metals and TDS; *high cost*
5c	New ARD WTP with Lime-Addition, Chemical Precipitation, Proprietary Sulfate Removal Process, and pH Adjustment (375 gpm)	Moderate	Moderate	Very High	Not calculated	Not calculated	No	*Removal efficiency of TDS unknown*
5d	New ARD WTP with Ion Exchange, Full Stream Membrane Filtration, and pH Adjustment (375 gpm)	Low	Low	Very High	Not calculated	Not calculated	No	*Not feasible* with high TDS concentrations and aggressive water
5e	New ARD WTP with Electrocoagulation and Partial Stream Membrane Filtration (375 gpm)	Low	Low	High	Not calculated	Not calculated	No	*Removal efficiency of TDS unknown; low sulfate removal efficiency*
5f	New ARD WTP with Anaerobic Sulfate Reduction, Metal Sulfide/Carbonate Precipitation, and Partial Stream Membrane Filtration (375 gpm)	Moderate	Moderate	Very High	$8,302,000	$4,215,000	No	Unknown metals and TDS removal efficiency; *high cost*

Table 5-1 Summary of Alternatives Screening

Alt.	Description	Effect.	Implement.	Cost	Capital Cost	Annual O&M Cost	Retained for Analysis?	Screening Comment
5g	New ARD WTP with Microencapsulation /Precipitation, and Full Stream Membrane Filtration (375 gpm)	Moderate	Moderate	High	$4,146,000	$5,246,000	No	*Potential* for metals removal and TDS control; *high cost proprietary process*
5h	New ARD WTP with Optimized Chemical Precipitation Using Proprietary Metals Coordination Process and Full Stream Membrane Filtration (375 gpm)	High	Moderate	High	$4,668,000	$4,208,000	No	*Potential* for metal removal and TDS control; *high cost proprietary process*
6a	Upgrade Existing Caustic Chemical Precipitation ARD WTP With Additional Treatment Train and Filtration (Interim ARAR Waiver) (375 gpm)	High (with interim ARAR waiver)	High	Moderate	$1,860,000	$4,341,000	Yes	*Effective* metals removal; *TDS not reduced; low cost*
6b	Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Addition and Upgrade With Additional Treatment Train and Filtration (Interim ARAR Waiver) (375 gpm)	High (with interim ARAR waiver)	High	Moderate	$3,248,000	$3,032,000	Yes	*Effective* metals removal and partial TDS control; *relatively low cost*
6c	Construct New Proprietary Microencapsulation/Precipitation ARD WTP (Interim ARAR Waiver) (375 gpm)	Moderate (with interim ARAR waiver)	Moderate	Moderate	$2,583,000	$4,010,000	Yes	*Potential* for metals removal including selenium
6d	Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (Interim ARAR Waiver) (375 gpm)	High (with interim ARAR waiver)	Moderate	Moderate	$3,928,000	$2,776,000	Yes	*Potential* for metals removal including selenium

Note: "Not calculated" values in Table 5-1 indicate alternatives that were screened out based on effectiveness, implementability, or excessive cost and did not warrant a more detailed cost analysis.

As discussed in Section 2, a significant product of the chemical reactions in the ARD process is the formation of sulfate compounds that remain in solution, resulting in highly elevated TDS. Sulfate compounds are the primary reason that ARD generated at the Site exceeds the TDS ARAR. The scientific basis for the current TDS standard is not definitive, so EPA and SDDENR have determined that a site-specific toxicology study should be conducted to determine the specific toxicity-characteristics of metals sulfate TDS and specific metals to site-specific aquatic life, and more accurately establish appropriate site-specific TDS and metals risk based thresholds. This study will allow for determination of the relevance and suitability of the existing TDS ARAR standard and for development of risk-based sulfate TDS and metals limits (IRAGs) for surface water leaving the site.

Selenium, although it is a metal, is not easily removed from solution by precipitation at high pHs. Rather selenium is more effectively removed by adsorption onto an iron precipitate at pHs <4. This significant difference in optimum removal conditions makes simultaneous efficient removal of selenium and other metals very difficult. However, selenium can be removed by membrane filtration processes like other TDS constituents. Investigation of selenium removal methods using anaerobic biological processes is underway at Gilt Edge and other ARD generating sites.

EPA expects that all treatment system(s) considered in this FFS will produce reductions in TDS and selenium concentrations; however, while all the treatment systems considered herein can achieve all other ARARs, some alternatives were presented that will not achieve strict compliance with the current TDS and selenium ARARs during the interim period before the final sitewide remedial action is implemented. It is anticipated that elements of the remedial action to be undertaken at the site (waste containment and capping) will reduce the total volume and ARD concentrations such that a final water treatment system(s) can more effectively achieve required TDS and selenium standards.

In summary, because of the uncertainty regarding toxicity factors, the limited time frame of the interim water treatment operations, and the much higher costs associated with meeting the TDS and selenium ARARs (see Table 5-1), the alternatives considered in this section provide a comparative basis to assess whether an interim waiver of the TDS and selenium ARARs is appropriate and advisable for an interim water treatment action. Waivers of specific ARARs are discussed in paragraph 3.2.1.4. Interim waivers of the TDS and selenium ARARs would allow for completion of the toxicology study and determination of a risk-based sulfate/TDS standard as well as further investigation of effective selenium removal technologies. Interim waivers of these ARARs have been considered by EPA, SDDENR, and the South Dakota Department of Game, Fish, and Parks and there is concensus that for the interim, these waivers have merit. Consequently, alternatives were screened based upon the presumption of an interim waiver of the TDS and selenium ARAR requirements. As a result, alternatives retained for detailed analysis in Section 7 include an interim waiver of the TDS and selenium ARARs. However, the interim ARAR waivers are only applicable to the interim water treatment operations addressed in this FFS.

The final site remedy developed under subsequent Site feasibility studies and remedial actions will comply with all federal, state, and local ARAR requirements.

5.5 Alternatives Retained for Detailed Analysis

Screening comments included in Table 5-1 provide the basis for eliminating or retaining alternatives for detailed analysis. Based on the screening of the alternatives, the following alternatives were retained for detailed analysis in Section 7.

- Alternative 1: No Action
- Alternative 3: Route Hoodoo Gulch and Pond C ARD to WTP (with Alternative 6)
  - — Alternative 3a: Divert ARD Seep Flows from Hoodoo Gulch to Sunday Pit; Divert Pond C ARD Seep Flows to Pond D
  - — Alternative 3b: Divert ARD Seep Flows from Hoodoo Gulch to Strawberry Pond; Divert Pond C ARD Seep Flows to Pond D
- Alternative 6: Interim ARAR Waiver Treatment Plant
  - — Alternative 6a: Upgrade Existing Caustic Chemical Precipitation ARD WTP With Additional Treatment Train and Filtration (Interim ARAR Waiver)
  - — Alternative 6b: Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Addition and Upgrade With Additional Treatment Train and Filtration (Interim ARAR Waiver)
  - — Alternative 6c: Construct New Proprietary Microencapsulation/Precipitation ARD WTP (Interim ARAR Waiver)
  - — Alternative 6d: Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (Interim ARAR Waiver)

Section 6
Definition of Criteria Used in the Detailed Analysis of Retained Alternatives

In accordance with the NCP, the alternatives retained after completion of the screening step of the FS process are evaluated using the following nine criteria. In order to establish priority among these criteria, they are separated into three groups. The first two criteria listed, Overall Protection of Human Health and the Environment and Compliance with ARARs, are threshold criteria and must be satisfied by the remedial action alternative being considered. The next five criteria (Long-Term Effectiveness and Permanence; Reduction of Toxicity, Mobility, or Volume through Treatment; Short-Term Effectiveness; Implementability; and Cost) are secondary criteria used as balancing criteria among those alternatives that satisfy the threshold criteria. State Acceptance and Community Acceptance, the last group of criteria, are not evaluated during the FFS.

6.1 Overall Protection of Human Health and the Environment

Each alternative will be assessed to determine whether it can adequately protect human health and the environment, in both the short- and long-term, from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the Site by eliminating, reducing, or controlling exposures to levels established during development of remediation levels. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

6.2 Compliance with ARARs

Each alternative will be assessed to determine whether it will comply with ARARs under federal and state environmental or facility siting laws. ARARs for the Site interim water treatment remedial action are included in Appendix A of this document. A summary of the water quality standards from the ARARs used to develop the IRAGs is presented in Table 3-1 in Section 3 of this FFS. As defined in paragraph 3.2.1.4 and discussed in paragraph 5.4, a waiver of the TDS and selenium ARARs is recommended for the interim water treatment period. The recommendation for the waiver is based on the significant cost associated with complying with these ARARs and that the ARARs will be met as a part of the final site remedy when it is completed. Satisfaction of the ARAR threshold criteria in Section 7 for the alternatives retained for detailed analysis will be based on compliance with the water quality standards listed in Table 3-1 in Section 3 with the exception of TDS and selenium.

6.3 Long-Term Effectiveness and Permanence

Each alternative will be assessed for the long-term effectiveness and permanence it affords, along with the degree of certainty that the alternative will prove successful. Factors to be considered, as appropriate, include the following:

- Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the remedial activities. The characteristics of the residuals are considered to the degree that they remain hazardous, taking into account their toxicity, mobility, and/or volume and propensity to bioaccumulate.

- Adequacy and reliability of controls such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses the uncertainties associated with land disposal for providing long-term protection from residuals; the assessment of the potential need to replace technical components of the alternative; and the potential exposure pathways and risks posed should the remedial action need replacement.

- The compliance of the alternative with both interim remedial action goals and ARARs.

6.4 Reduction of Toxicity, Mobility, or Volume through Treatment

The degree to which each alternative employs technology to permanently and significantly reduce toxicity, mobility, and/or volume will be assessed, including how treatment is used to address the principal threats posed by the Site. Factors to be considered, as appropriate, include the following:

- The treatment or recycling processes the alternatives employ and materials they will treat

- The amount of hazardous substances, pollutants, or contaminants that will be destroyed, treated, or recycled

- The degree of expected reduction in toxicity, mobility, and/or volume of the waste due to treatment and/or recycling and the specification of which reduction(s) are occurring

- The degree to which the treatment is irreversible

- The type and quantity of residuals that will remain following treatment, considering the persistence, toxicity, mobility, and propensity to bioaccumulate such hazardous substances and their constituents

- The degree to which treatment reduces the inherent hazards posed by principal threats at the Site

6.5 Short-Term Effectiveness

The short-term impacts of each alternative will be assessed considering the following factors:

- Short-term risks that might be posed to the community during implementation of an alternative
- Potential impacts on workers during remedial action and the effectiveness and reliability of protective measures
- Potential environmental impacts of the remedial action and the effectiveness and reliability of mitigative measures during implementation
- Time until protection is achieved

Alternatives having fewer impacts to the community, workers, and the environment during implementation, and those using reliable protective measures meet the short-term effectiveness criteria to a greater extent than alternatives with greater impacts. Alternatives requiring a short period of time until protection is achieved are more favorable than those requiring a longer time frame.

6.6 Implementability

The ease or difficulty of implementing each alternative will be assessed by considering the factors, as appropriate.

- Technical feasibility, including technical difficulties and unknowns associated with the construction and operation of a technology, the reliability of the technology, ease of undertaking additional remedial actions, and the ability to monitor the effectiveness of the remedy
- Administrative feasibility, including activities needed to coordinate with other offices and agencies and the ability and time required to obtain any necessary approvals and permits from other agencies (for offsite actions)
- Availability within a reasonable time frame of services and materials, including the availability of adequate offsite treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and specialists and provisions to ensure any necessary additional resources; the availability of services and materials; and availability of prospective technologies

6.7 Cost

The costs that are assessed include the following:

- Capital costs
- Annual O&M costs, including both direct and indirect costs
- Present worth of capital and O&M costs

The present worth of each alternative provides the basis for the cost comparison. The present worth cost represents the amount of money that, if invested in the initial year of the remedial action at a given rate, would provide the funds required to make future payments to cover all costs associated with the remedial action over its planned life.

The present worth analysis was performed on all retained remedial alternatives using a 7 percent discount (nominal) rate. Depreciation and inflation were not considered in preparing the present worth costs.

In a typical FS, often a time period of 30 years is used in the present worth analysis of annual O&M costs when those activities will continue indefinitely. However, for the purpose of this interim water treatment FFS, the period of operation is determined by the schedule of site closure activities. In other words, the duration of interim water treatment will correspond with the duration of closure activities. Upon site closure, a final water treatment remedy identified in a final FS will be selected and implemented. Since water treatment operations at the Site are so costly and the open mine pits may require dewatering for completion of site closure activities, EPA requested that a detailed cost analysis be prepared to determine the most cost effective treatment capacity (flow rate). The most cost effective treatment capacity minimizes total water treatment costs, including capital and O&M expenditures, during the interim water treatment period. This cost is subsequently referred to as the minimum cost to site closure (MCSC) for interim water treatment and represents the optimum combination of capital and O&M expenditures.

For this analysis, capital expenditures are those expenditures to construct water treatment facilities, while O&M costs are those direct and indirect expenditures to operate the water treatment facility. At the request of EPA, O&M expenditures also include overall site administration expenses consisting of sampling, site security, snow removal, and site office operations. In order to determine the MCSC for interim water treatment, it was necessary to determine the optimum combination of capital and O&M expenditures. The MCSC was determined using a present worth analysis of capital and O&M cost estimates at different treatment capacities. Each treatment capacity requires a certain amount of capital expenditure and has a period of operation required to dewater the site determined by the amount of water currently in storage onsite and the precipitation that occurs at the site over the period of operation. The capital costs in conjunction with the O&M costs for the time period associated with the treatment capacity were used to develop the present worth costs that allow for the determination of the optimum balance of capital and O&M expenditures.

With expenditure of capital, additional treatment capacity can be purchased to reduce the time required to dewater the Site, which allows the Site closure and reclamation activities to proceed (as mentioned previously, dewatering of the Sites open mine pits may be required for closure and reclamation activities to be completed). Reducing the time to dewater the Site minimizes O&M costs by reducing the time frame that the treatment facility is operational and by reducing the overall volume of ARD requiring treatment. For each year that the Site remains unreclaimed, surface water runoff from the Site must be collected and treated to ensure that untreated ARD does not migrate off of the Site to Strawberry and Bear Butte Creeks. In a year of average precipitation (27 inches), an additional 90 million gallons of runoff require treatment. However, excessive capital costs to increase treatment capacity allowing a shorter period of operation can offset the O&M costs, thereby increasing the total present worth cost for interim water treatment.

The purpose of the cost versus treatment capacity analysis requested by EPA was to determine the capacity that corresponds to the MCSC for water treatment and to provide a decisionmaking tool for expenditure of capital during the interim water treatment period. Only Alternatives 6a and 6b retained for detailed analysis in Section 5 are used in the MCSC analysis. Since Alternatives 6c and 6d, also retained in Section 5 for detailed analysis, are similar to Alternatives 6a and 6b and are anticipated to display a similar capital and O&M optimum cost relationship, they are not included in the MCSC analysis. Additionally, the capital costs and annual chemical costs for Alternatives 6c and 6d cannot be independently verified and can only be obtained from the process designers.

In addition to determining the MCSC, EPA had concerns about the possibility of discharge of untreated ARD from the Site during large storm events or high precipitation years. The last few years at the Site have been relatively dry allowing the existing water treatment facility to treat the ARD generated and to make progress in dewatering the Site by treating water held in storage from the various open pits. Since discharge of untreated ARD from the Site is dependent upon WTP capacity, an additional analysis was performed to provide EPA with the risk of untreated discharge associated with the different treatment capacities used in the MCSC analysis. The purpose of this analysis was to provide an additional decisionmaking tool to EPA to manage the risk of untreated discharge from the Site and to help determine the required treatment capacity for interim water treatment.

The treatment rate of 375 gpm (the maximum treatment capacity required corresponding to the maximum annual precipitation of 43 inches) associated with Alternatives 6a, 6b, 6c, and 6d in Section 5 allowed for comparison with other Section 5 alternatives. The MCSC analysis and untreated discharge risk analysis will be used to determine the treatment capacity, which subsequently will be used for the detailed analysis of these alternatives in Section 7.

6.7.1 Approach

Both the MCSC and concern of untreated ARD discharge from the Site depend on the following three variables: WTP capacity, open pit storage volume, and future precipitation. In order to quantify concerns of untreated ARD discharge from the Site, probability/risk was selected as the measure of concern. Probability/risk of untreated discharge from the site is dependent upon WTP capacity, open pit storage volume, and future precipitation. For example, untreated discharge would occur when open pit storage is full and surface water runoff is greater than the WTP capacity. Since surface water runoff flow rates during a storm event can be over 10,000 gpm, untreated discharge is eminent when open pit storage is full. Available open pit storage volume is dependent upon the amount of surface water runoff and the WTP capacity (i.e., open pit storage volume increases when the WTP capacity is greater than the average surface water runoff flow rate). Surface water runoff is directly related to precipitation.

The MCSC is quantified in terms of present worth costs dependent on capital expenditure to obtain treatment capacity and O&M costs for the time period required to dewater the Site. The length of time required to dewater the Site is dependent upon WTP capacity, the volume of water currently in storage, and future precipitation. For example, in an average year of precipitation, an average of 170 gpm of treatment capacity is needed to prevent additional accumulation of ARD onsite. A treatment rate of less than 170 gpm would eventually allow discharge of untreated ARD from the site. At treatment rates greater than 170 gpm, ARD currently stored in the open pits on the site can be treated to allow dewatering of the site. At a treatment rate of 250 gpm for a year of average precipitation, an average of 80 gpm of ARD stored in the open pits can be removed and treated. At 300 gpm treatment capacity, 130 gpm can be removed and treated, etc. During years of more or less precipitation, more or less ARD can be removed from storage and treated. The combinations of treatment capacity and future precipitation along with the current volume of ARD stored onsite determine the corresponding time periods to dewater the site. To perform the analysis for MCSC and probability of untreated ARD discharge from the Site, values for the three independent variables of WTP capacity, future precipitation, and open pit storage volume were determined as described in the following paragraphs.

6.7.1.1 Water Treatment Capacity

The existing WTP is currently being operated at 250 gpm. In addition to this flow rate, water treatment capacities were selected in 100-gpm increments from 300 gpm to 800 gpm. Capital and O&M costs were estimated for each treatment capacity and were used to develop the present worth costs for each treatment capacity.

6.7.1.2 Future Precipitation

Since future precipitation is not known with certainty, a stochastic analysis of monthly precipitation data from the past 40 years was used to develop probable precipitation outputs for a series of months. Stochastic monthly precipitation outputs

account for the interdependence between monthly precipitation events by using a "relational" coefficient that creates a dependence of the probabilities of precipitation in month two on the precipitation in month one and the precipitation in month three on the precipitation in month two, etc.

6.7.1.3 Open Pit Storage Volume

The stochastic precipitation outputs were incorporated into the Site water balance model that accounts for the overall Site water balance based on precipitation, evapotranspiration, WTP flow rate, and pit storage volumes. For a given treatment plant flow rate, the probabilities of the stochastic precipitation series were used to generate probabilities of pit storage volumes.

Probabilities of pit storage volumes were subsequently used to estimate the probability of untreated ARD discharge (i.e., probability that the pits are full; storage volume = 0) and the number of years required to dewater the Site (i.e., probability that the pits are empty; storage volume = volume of the pit). It was assumed for this analysis that the current volume of water onsite requiring treatment for completion of site closure activities is equal to the volume of water currently stored in the Sunday and Anchor Hill Pits (approximately 110,000,000 gallons). For a more detailed discussion and explanation of the water balance model and incorporation of the stochastic precipitation estimates to determine probabilities of untreated ARD discharge and the number of years required to dewater the Site at the different WTP flow rates, see Appendix C.

6.7.2 Analysis

The number of years required to dewater the Site with 90, 95, and 99 percent certainty were selected for the MCSC analysis. For each WTP capacity, a period of time (years) was generated from the water balance model corresponding to these levels of certainty (or probability) that the Site would be dewatered (i.e., Sunday Pit would have an available storage volume equal to its total volume). The number of years corresponding to the treatment plant flow rates and levels of certainty are listed in Table 6-1. For each WTP capacity, the number of years corresponding to each level of certainty was used to determine the present worth of water treatment costs using the discount mentioned previously. Present worth values are comprised of the sum of capital costs and O&M costs (as the product of the annual O&M estimate and the calculated present worth factor associated with the number of months of treatment).

It was assumed in this analysis that the existing sodium hydroxide treatment plant could provide 300 gpm of treatment capacity as a sodium hydroxide treatment plant with limited capital investment for the addition of an outdoor circular clarifier, post sedimentation filtration, and final pH adjustment equipment and that it could be converted to provide 300 gpm of treatment capacity as lime N/P treatment plant with limited capital investment for a lime slaking and slurry feed system along with the addition of an outdoor circular clarifier, post sedimentation filtration, and final pH adjustment equipment (see Cost Spreadsheets in Appendix D for capital investment

amount). These assumptions are based on the original plant design capacity of 360 gpm reported by BOR (BOR 2000), and current WTP operations. Any additional treatment capacity was assumed to require capital investment in a new plant to operate in parallel with the existing plant. It was also assumed that sludge would be disposed of onsite in existing lined ponds and pads as discussed in Section 5. Present worth values for each of the treatment flow rates are presented in Table 6-2. Three present worth cost curves for Alternative 6a corresponding to each level of certainty with respect to WTP flow rate are shown on Figure 6-1.

Table 6-1 Summary of Probabilities and Number of Years to Dewater

Flow Q (gpm)	Probability of Less Than # of Years to Dewater Storage		
	90	95	99
250	3.7	–	–
300	1.1	2.1	–
400	0.8	1.3	–
500	0.7	0.8	3.1
600	0.5	0.6	0.8
700	0.4	0.5	0.7
800	0.4	0.4	0.7

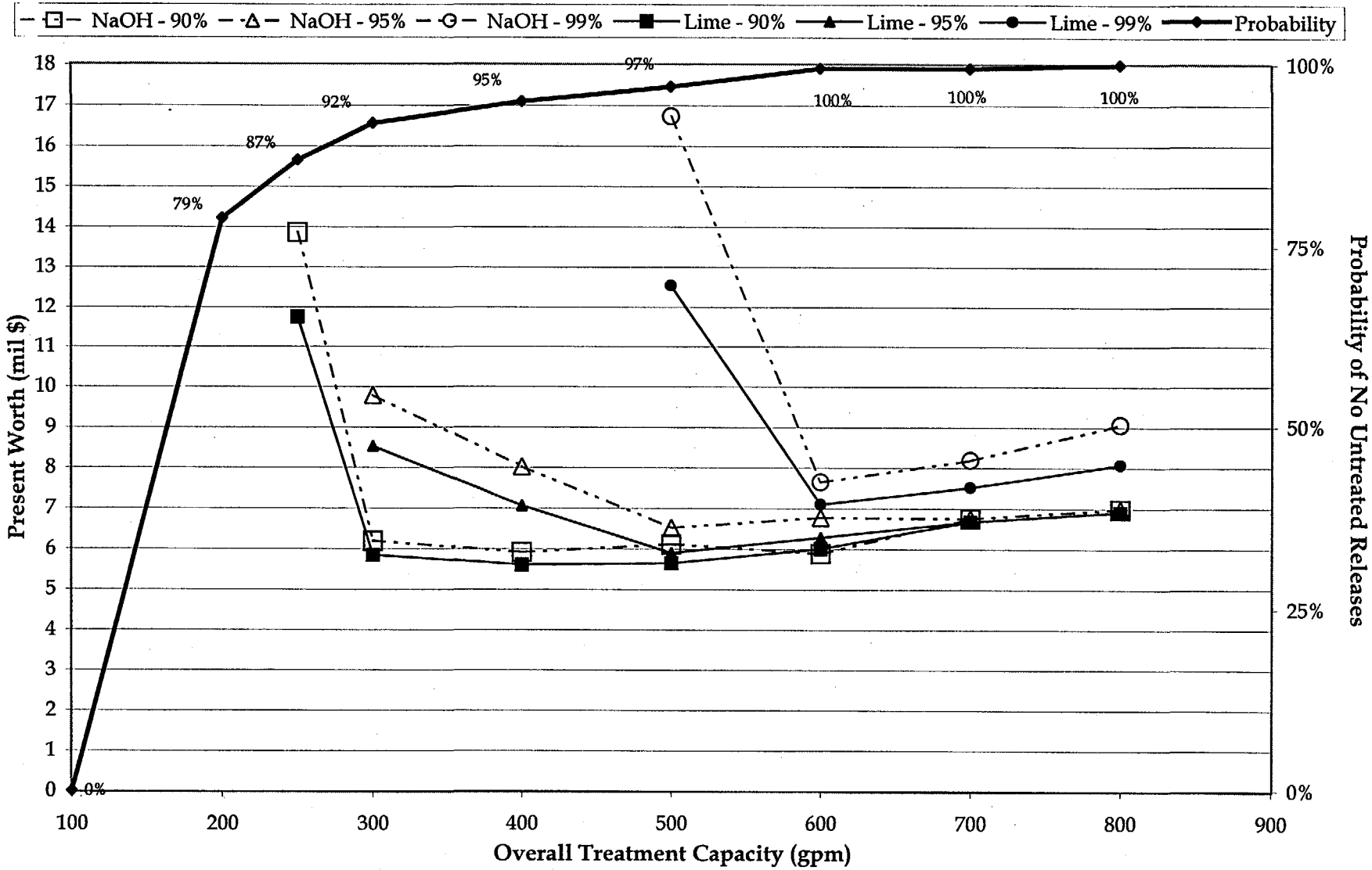
"–" Denotes a period >5 years to treat the present storage volume onsite

Table 6-2 Comparison of Present Worth Costs for Metal Hydroxide Precipitation

Q (gpm)	Capital Cost ($)	Annual O&M Cost ($)	Present Worth Cost (mil $)		
			90%	95%	99%
NaOH Addition					
250	1,364,000	3,787,000	13.87	–	–
300	1,690,000	4,030,000	6.20	9.79	–
400	2,261,000	4,533,000	5.92	8.02	–
500	2,462,000	5,020,000	6.12	6.52	16.73
600	3,183,000	5,523,000	5.89	6.77	7.65
700	3,808,000	6,009,000	6.75	6.75	8.19
800	4,313,000	6,512,000	6.98	6.98	9.06
Calcium Oxide (CaO) Addition					
250	2,054,000	2,938,000	11.76	–	–
300	2,496,000	3,001,000	5.85	8.53	–
400	3,078,000	3,139,000	5.61	7.07	–
500	3,277,000	3,258,000	5.65	5.91	12.54
600	4,352,000	3,396,000	6.02	6.29	7.10
700	4,954,000	3,519,000	6.68	6.68	7.52
800	5,412,000	3,656,000	6.91	6.91	8.08

"–" Denotes a cost for a period >5 years to treat the present storage volume onsite

Figure 6-1. Present Worth Cost Analysis of ARD Water Treatment Plant Flow Rates



Probabilities of no untreated ARD discharge from the Site (i.e., probability that the pits are not full; storage volume is >0) corresponding to various treatment plant flow rates are presented in Table 6-3. Additionally, these probabilities are represented graphically along the present worth cost curves for the MCSC analysis on Figure 6-1.

Table 6-3 Probability of Untreated Release during a Year

Q (gpm)	Untreated Release	No Untreated Release
0	100%	0%
100	100%	0%
200	21%	79%
250	13%	87%
300	8%	92%
400	5%	95%
500	3%	97%
600	0.5%	99.5%
700	0.5%	99.5%
800	0.0%	100%

6.7.3 Conclusions

From the MCSC and probability of untreated ARD discharge analysis, the following conclusions can be made:

- For both sodium hydroxide and lime treatment processes, the minimum cost to closure time frame for water treatment is shorter than the time frame required to complete site closure activities. In light of this conclusion the following additional conclusions can be made:
  - The absolute minimum cost to closure for water treatment activities cannot be achieved due to the schedule for site closure and reclamation activities. The site closure and reclamation activities will require longer to complete than the time corresponding to the MCSC for interim water treatment.
  - The minimum cost to closure for water treatment activities is therefore determined by the schedule of the site closure and reclamation activities. The shorter the duration of the closure activities, the less cost will be incurred for water treatment.
- O&M expenditures represent the predominant costs in the present worth of water treatment at capacities up to 500 gpm. At treatment rates higher than 500 gpm, the capital cost required to obtain the treatment capacity offsets the savings obtained by a shorter period of operation.
- The optimum water treatment flow rate at 95 percent certainty of dewatering is observed to be approximately 500 gpm. At this treatment flow rate, present worth cost is minimized. However, the time to dewater the Site (approximately 0.8 years) is less than the time required to complete site reclamation activities. Therefore, after the Site is dewatered, the treatment plant would be required to operate on a part

time/seasonal basis corresponding to the time required to treat the runoff associated with each additional month of operation required for reclamation activities.

- The optimum water treatment plant flow rate to minimize water treatment costs also minimizes risk of untreated discharge from the Site.
- Water treatment at flow rates less than the optimum flow rate provide dewatering of the Site in a time period that corresponds to the anticipated Site closure schedule. Although these lower treatment flow rates do not provide the MCSC, minimization of water treatment costs for the interim period can be achieved by selecting a flow rate that dewaters the site in a time period less than the time period anticipated for site closure activities.
- Water treatment using a lime N/P process is less costly than using a sodium hydroxide N/P process.

Since the existing treatment facility is assumed to have an optimized treatment capacity of 300 gpm and this flow rate allows for dewatering of the Site in a time period that does not interfere with the anticipated site closure schedule, a WTP flow rate of 300 gpm is used to compare present worth costs of Alternatives 6a, 6b, 6c, and 6d in Section 7. For Alternatives 6a and 6b it is assumed that the existing sodium hydroxide treatment plant would be used for 300 gpm of treatment capacity as either a sodium hydroxide or converted lime precipitation plant. For Alternatives 6c and 6d it was assumed that a new 300-gpm treatment plant using the proprietary microencapsulation or metals coordination process would be constructed.

Appendix D contains spreadsheets showing each component of the present worth costs. These costs were prepared in accordance with the EPA guidance (EPA 2000). As mentioned previously, costs developed in this analysis assume onsite sludge disposal.

6.8 State Acceptance

Assessment of state concerns will not be completed until comments on the final FFS are submitted to EPA. Therefore, state acceptance is not considered in the detailed evaluation of alternatives presented in this technical memorandum.

6.9 Community Acceptance

This assessment will include responses to any questions interested persons in the community have regarding any component of these remedial action alternatives presented in the final FFS for the Gilt Edge Mine interim water treatment remedial action. This assessment will be completed after EPA receives public comments on the FFS. Therefore, community acceptance is not considered in the detailed evaluation of alternatives presented in this technical memorandum.

Section 7
Detailed Analysis of Retained Alternatives

The analysis of how the retained alternatives from paragraph 5.4 satisfy each of the detailed analysis criteria described in Section 6 of this FFS is presented below. Each alternative is rated marginally, moderately, highly, or very highly effective in meeting each of the seven criteria.

As discussed in Section 5, alternatives will be analyzed using costs for onsite sludge disposal in existing lined ponds and pads. Should this assumption not prove feasible due to regulatory or other site closure issues, additional costs for onsite or offsite sludge disposal need to be added to annual O&M costs presented in this section to obtain true alternative costs.

The following alternatives were retained in paragraph 5.4 for detailed analysis.

- Alternative 1: No Action
- Alternative 3a: Divert ARD Flow from Hoodoo Gulch to Sunday Pit; Divert ARD flow from Pond C to Pond D
- Alternative 3b: Divert ARD Flow from Hoodoo Gulch to Strawberry Pond; Divert ARD flow from Pond C to Pond D
- Alternative 6a: Upgrade Existing Caustic Chemical Precipitation Treatment Plant with Filtration (Interim ARAR Waiver)
- Alternative 6b: Convert Existing Caustic Chemical Precipitation Treatment Plant to Lime Precipitation and Upgrade with Filtration (Interim ARAR Waiver)
- Alternative 6c: Construct New Microencapsulation/Precipitation Treatment Plant (Interim ARAR Waiver)
- Alternative 6d: Construct New Optimized Chemical Precipitation Treatment Plant Using Proprietary Metals Coordination Process (Interim ARAR Waiver)

7.1 Alternative 1: No Action

The No Action alternative would discontinue current ARD treatment with the existing sodium hydroxide N/P WTP. ARD would continue to be generated and fill any storage volume currently available in the open pits. Once the pits reach their storage capacity, untreated ARD would discharge to Strawberry Creek and Bear Butte Creek via the Hoodoo Gulch, Ruby Gulch, and Strawberry Creek drainages. There would be no change in ARD contaminant concentrations because no treatment, containment, or removal of contaminants from ARD is included in this alternative. Alternative 1 includes surface water monitoring and 5-year site reviews since ARD would continue to migrate off the Site indefinitely. Additionally, Alternative 1 would

require pumping of untreated ARD from the open pits to Strawberry Creek to allow other site closure activities to occur.

The No Action alternative is carried through the FFS process to provide a baseline for comparisons of site remedial alternatives as required by the NCP. Since this alternative does not address treatment of ARD at the Site, it does not meet any of the IRAGs for the Site as defined in paragraph 3.1 of this FFS. Also, this alternative is not protective of human health and the environment, is not compliant with ARARs, has no long-term or short-term effectiveness, and does not provide a reduction in toxicity, mobility, or volume of ARD. Since it only involves surface water monitoring and 5-year site reviews, this alternative is very highly implementable and very cost effective. The estimated present worth cost of this alternative is $476,000. Spreadsheets in Appendix D summarize the cost elements of Alternative 1.

7.2 Alternative 3a: Divert ARD Seep Flows from Hoodoo Gulch to Sunday Pit; Divert Pond C ARD Seep Flows to Pond D

7.2.1 Description

The individual ARD seeps from Hoodoo Gulch would be collected in concrete sumps and flow by gravity to a seep storage tank. Water collected in the tank from the sumps would subsequently be pumped to Sunday Pit. The seep flows upstream (east) of Pond C would be intercepted as surface water runoff in a HDPE-lined channel located to the east of Pond C. The channel would flow to the south with discharge to Pond D. The routing of Hoodoo Gulch (via Sunday Pit) and Pond C (via Pond D) seep flows to the WTP would ensure effective treatment and reduce the contaminant loadings to Strawberry Creek. This alternative would be implemented with one of Alternatives 6a, 6b, 6c, or 6d.

Figure 7-1 illustrates the proposed locations of the seep collection sumps, storage tank, the pipeline alignment from Hoodoo Gulch to Sunday Pit, and the diversion channel from Pond C to Pond D.

Alternative 3a would consist of operating the pumps. Other O&M costs are assumed to be covered as part of the annual O&M practices for Alternatives 6a, 6b, 6c, or 6d.

Pond C

Alternative 3A and Alternative 3B

Dakota Maid Pit

Sunday Pit

Pond D

Main Office

Pond E

Strawberry Pond Pumphouse

Alternative 3A

HooDoo Gulch

SC-SP-09

SC-SP-10

SC-SP-11

SC-SP-13

SC-SP-12

SC-SP-14

HOODOO WEST SPRING

HOODOO EAST SPRING

SC-SE-06

SC-SP-17

Cabin Creek

Langley Pit

Alternative 3B

Strawberry Creek

LEGEND

- Unaffected Spring
- Unaffected Seep
- Seep Collection Sump
- Seep Collection Storage Tank With Submersible Pump
- Seep Collection Piping
- Acid Rock Drainage Collection Trench
- Creek or Stream
- Topographic Contour, 5-foot Interval
- Improved Gravel Road
- Unmaintained Road
- Building or Tank
- Lake or Pond

N

100 0 100 200 Feet

CDM Federal Programs Corporation

FIGURE 7-1

HOODOO GULCH SEEP COLLECTION ALTERNATIVES

GILT EDGE MINE
LAWRENCE COUNTY, SOUTH DAKOTA

05-11-01 m:\3280-rac81048-gilledge\gis\swstdy1.apr SeepsWaterTr

7.2.2 Overall Protection of Human Health and the Environment

Alternative 3a would significantly reduce migration of metal contaminants and acid water to Strawberry Creek from Hoodoo Gulch and Pond C by collecting and allowing for subsequent treatment of the ARD seep flows. Treatment of the seep flows in the WTP would reduce the metals contaminant concentrations and adjust the discharge pH to the neutral range (6.0 to 9.0) and allow for discharge of a consistently treated effluent to Strawberry Creek. However, overall protection of human health and the environment will be affected by the treatment effectiveness of Alternative 6a, 6b, 6c, or 6d with which Alternative 3a will be combined. Alternative 6a is not effective in treating TDS and its effectiveness for selenium removal is unknown. Alternative 6b may reduce TDS below the ARAR limit while its effectiveness for selenium removal is also unknown. Alternative 6c may reduce TDS below the ARAR limit and may also be effective in removing selenium. Alternative 6d may also reduce TDS below the ARAR limit and in a pilot-scale study has shown effectiveness in reducing selenium below the ARAR limit. Therefore, Alternative 3a is determined to be highly effective in protecting human health and the environment when combined with Alternative 6a, 6b, 6c, or 6d.

7.2.3 Compliance with ARARs

Because Alternative 3a prevents untreated ARD from leaving the Site, it addresses all of the IRAGs outlined in paragraph 3.1 for surface water migrating off of the Site. However, the overall compliance with ARARs for Alternative 3a will be affected by the treatment effectiveness of Alternative 6a, 6b, 6c, or 6d with which Alternative 3a will be combined. Alternative 6a is not effective in treating TDS and has low effectiveness for selenium removal. Alternative 6b may reduce TDS below the ARAR limit and may have moderate effectiveness for selenium removal. Alternative 6c may reduce TDS below the ARAR limit and may also be effective in removing selenium. Alternative 6d may also reduce TDS below the ARAR limit and in a pilot-scale study, has shown effectiveness in reducing selenium below the ARAR limit. Design and construction of Alternative 3a will be in accordance with state, federal, and local requirements. Alternative 3a is determined to be highly effective in meeting ARARs when combined with Alternative 6a, 6b, 6c, or 6d with an interim ARAR waiver for TDS and selenium.

7.2.4 Long-Term Effectiveness and Permanence

The construction of seep collection, storage, pumping, and transmission facilities along with Alternative 6a, 6b, 6c, or 6d can provide effective long-term treatment of the Hoodoo Gulch and Pond C ARD seeps. Improperly maintained sumps, pumps, transmission lines, or the treatment plant constructed as part of Alternative 6a, 6b, 6c, or 6d could result in untreated ARD discharge to Strawberry Creek from Hoodoo Gulch. Alternative 3a is considered highly effective in the long-term, if proper O&M is performed.

7.2.5 Reduction of Toxicity, Mobility, or Volume through Treatment

The EPA Remedial Investigation/Feasibility Study (RI/FS) guidance (EPA 1988) states that reduction of toxicity, mobility, or volume is only accomplished by treatment. Since Alternative 3a involves collection and transmission of ARD seep flows for treatment, Alternative 3a is very highly effective in the reduction of toxicity, mobility, or volume of metal contamination and neutralization of acid when combined with Alternative 6a, 6b, 6c, or 6d.

7.2.6 Short-Term Effectiveness

Excavation and construction of sumps, transmission piping, and diversion channel could cause short-term exposure to airborne and waterborne contamination; however, this exposure could be reduced through dust control/suppression measures and hydraulic controls as well as proper use of appropriate levels of personal protective equipment during construction of Alternative 3a. Upon completion of construction, collection, pumping, and conveyance would provide an immediate reduction of the ARD water migrating to Strawberry Creek; therefore, Alternative 3a would have very high short-term effectiveness.

7.2.7 Implementability

The components of the Hoodoo Gulch and Pond C seep collection, storage, pumping, and conveyance systems are easily obtained and can be installed using conventional construction equipment. This alternative would require excavation, construction of concrete sumps, storage tank installation, trenching and pipe installation, pump installation, and channel construction and lining. Maintenance of the sumps, pumps, and diversion channel would be required. Overall, Alternative 3a is considered very highly implementable.

7.2.8 Cost

The estimated capital cost construction of Alternative 3a is $262,000. The annual O&M costs associated with operation of the pumps is $1,900. The total present worth cost for Alternative 3a is $266,000. Spreadsheets in Appendix D summarize the cost elements of Alternative 3a.

7.3 Alternative 3b: Divert ARD Seep Flows from Hoodoo Gulch to Strawberry Pond; Divert Pond C ARD Seep Flows to Pond D

7.3.1 Description

Alternative 3b is similar to Alternative 3a except that Hoodoo Gulch seep flows would be pumped to Strawberry Pond instead of Sunday Pit.

This alternative would be also be implemented with one of Alternatives 6a, 6b, 6c, or 6d.

Figure 7-1 illustrates the proposed locations of the seep collection sumps, storage tank, the pipeline alignment from Hoodoo Gulch to Strawberry Pond and the diversion channel from Pond C to Pond D.

Alternative 3b would consist of operation of the pumping system. Other O&M costs are assumed to be covered as part of the annual O&M practices for Alternatives 6a, 6b, 6c, or 6d.

7.3.2 Overall Protection of Human Health and the Environment

Alternative 3b would significantly reduce migration of metal contaminants and acid water to Strawberry Creek from Hoodoo Gulch and Pond C by collecting and allowing for subsequent treatment of the ARD seep flows. Treatment of the seep flows in the WTP would reduce the metals contaminant concentrations and adjust the discharge pH to the neutral range (6.0 to 9.0) and allow for discharge of a consistently treated effluent to Strawberry Creek. However, overall protection of human health and the environment will be affected by the treatment effectiveness of Alternative 6a, 6b, 6c, or 6d with which Alternative 3b will be combined. Alternative 6a is not effective in treating TDS and its effectiveness for selenium removal is unknown. Alternative 6b may reduce TDS below the ARAR limit while its effectiveness for selenium removal is also unknown. Alternative 6c may reduce TDS below the ARAR limit and may also be effective in removing selenium. Alternative 6d may also reduce TDS below the ARAR limit and in a pilot-scale study has shown effectiveness in reducing selenium below the ARAR limit. Alternative 3b is determined to be highly effective in protecting human health and the environment when combined with Alternative 6a, 6b, 6c, or 6d.

7.3.3 Compliance with ARARs

Because Alternative 3b prevents untreated ARD from leaving the Site, it addresses all of the IRAGs outlined in paragraph 3.1 for surface water migrating off of the Site. However, the overall compliance with ARARs for Alternative 3b will be affected by the treatment effectiveness of Alternatives 6a, 6b, 6c, or 6d with which Alternative 3b will be combined. Alternative 6a is not effective in treating TDS and has low effectiveness for selenium removal. Alternative 6b may reduce TDS below the ARAR limit and may have moderate effectiveness for selenium removal. Alternative 6c may reduce TDS below the ARAR limit and may also be effective in removing selenium. Alternative 6d may also reduce TDS below the ARAR limit and in a pilot-scale study has shown effectiveness in reducing selenium below the ARAR limit. Design and construction of Alternative 3b will be in accordance with state, federal, and local requirements. Alternative 3b is determined to be highly effective in meeting ARARs when combined with Alternative 6a, 6b, 6c, or 6d with an interim ARAR waiver for TDS and selenium.

7.3.4 Long-Term Effectiveness and Permanence

The construction of seep collection, pumping, and conveyance facilities along with Alternative 6a, 6b, 6c, or 6d can provide effective long-term treatment of the Hoodoo Gulch and Pond C ARD seeps. However, improperly maintained sumps, pumps, transmission lines, diversion channel, or the treatment plant constructed as part of Alternative 6a, 6b, 6c, or 6d could result in untreated ARD discharge to Strawberry Creek from Hoodoo Gulch. Therefore, Alternative 3b is considered highly effective in the long-term.

7.3.5 Reduction of Toxicity, Mobility, or Volume through Treatment

The EPA RI/FS guidance (EPA 1988) states that reduction of toxicity, mobility, or volume is only accomplished by treatment. Since Alternative 3b involves collection and transmission of ARD seep flows for treatment, Alternative 3b is very highly effective in the reduction of toxicity, mobility, or volume of metal contamination and neutralization of acid when combined with Alternative 6a, 6b, 6c, or 6d.

7.3.6 Short-Term Effectiveness

Excavation and construction of sumps, transmission piping, and diversion channel could cause short-term exposure to airborne and waterborne contamination; however, this exposure could be reduced through dust control/suppression measures and hydraulic controls as well as proper use of appropriate levels of personal protective equipment during construction of Alternative 3b. Upon completion of construction, collection, pumping, and conveyance would provide an immediate reduction of the ARD water migrating to Strawberry Creek; therefore, Alternative 3b would have very high short-term effectiveness.

7.3.7 Implementability

The components of the Hoodoo Gulch and Pond C seep collection, storage, pumping, and conveyance systems are easily obtained and can be installed using conventional construction equipment. This alternative would require excavation, construction of concrete sumps, storage tank installation, trenching, pipe installation, pump installation, and channel construction and lining. Maintenance of the sumps, pumps, and diversion channel would be required. Overall, Alternative 3b is considered very highly implementable.

7.3.8 Cost

The estimated capital cost construction of Alternative 3b is $307,000. The annual O&M costs associated with maintenance of the sumps and operation of the pumps is $1,900. The total present worth cost for Alternative 3b is $311,000. Spreadsheets in Appendix D summarize the cost elements of Alternative 3b.

7.4 Alternative 6a: Upgrade Existing Caustic Chemical Precipitation Treatment Plant with Filtration

7.4.1 Description

Alternative 6a consists of upgrading the existing sodium hydroxide WTP with a circular clarifier and filtration equipment for post sedimentation effluent polishing, at an optimized treatment capacity of 300 gpm. Solids produced by the process would be dewatered with a filter press and landfilled onsite. Final acid pH adjustment equipment would also be provided in the event that effluent pH requires adjustment to meet the discharge limit. However, pH adjustment is not currently required to meet the discharge limit. A process flow diagram for Alternative 6a is shown on Figure 7-2.

7.4.2 Overall Protection of Human Health and the Environment

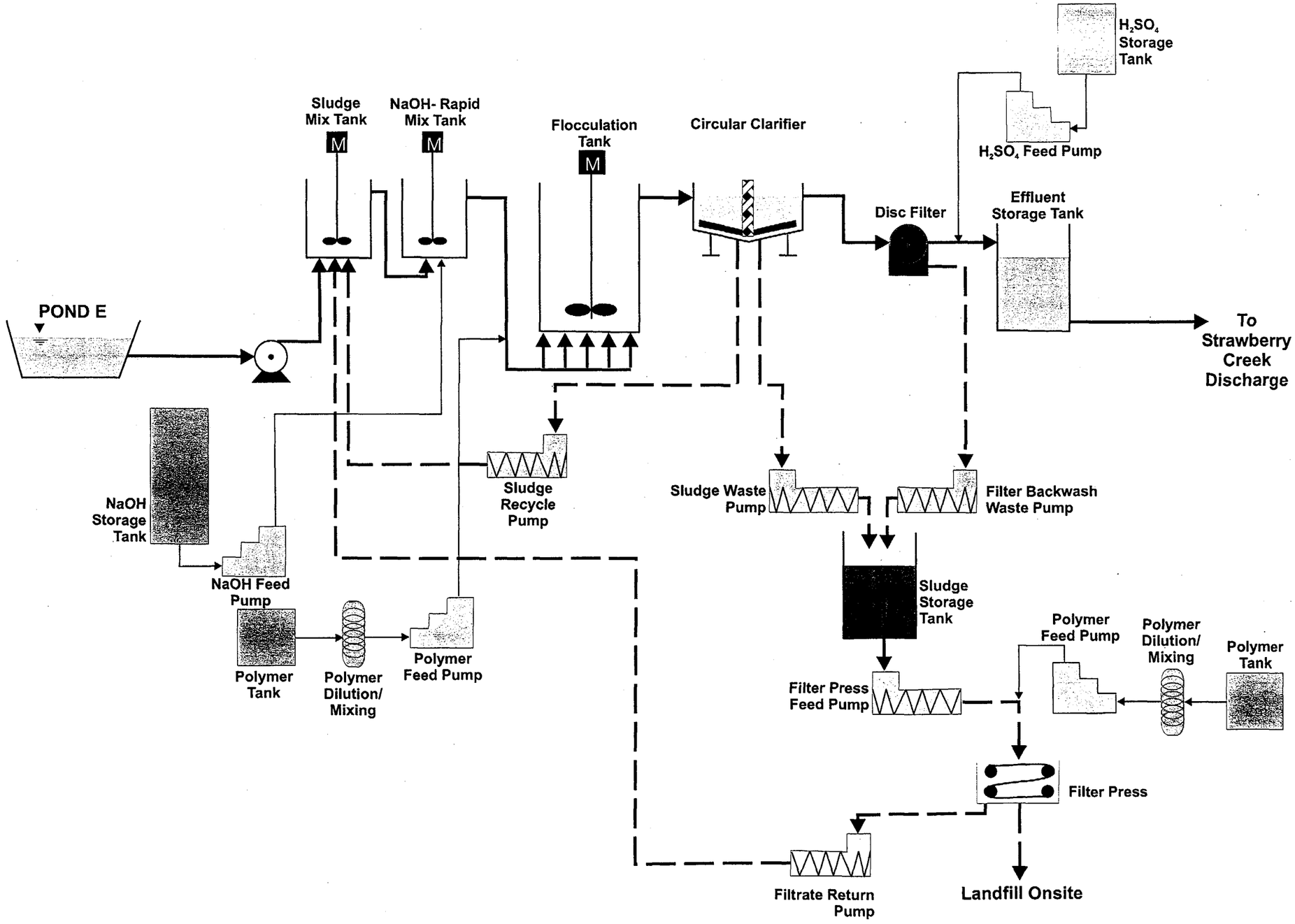
Alternative 6a would treat all of the ARD generated at the Site preventing an untreated discharge from the Site. The treatment provided by Alternative 6a would significantly reduce metals contamination and would raise discharge pH of surface water leaving the Site to the neutral range (6.0 to 9.0). Though the treatment train is not considered effective in treating selenium or TDS, Alternative 6a is considered to be highly protective of human health and the environment.

7.4.3 Compliance with ARARs

Because Alternative 6a addresses all of the IRAGs outlined in paragraph 3.1 for surface water leaving the Site except TDS and selenium, and the design and construction will be in accordance with state, federal, and local requirements, it is determined to be highly effective in meeting ARARs with an interim TDS and selenium ARAR waiver or a higher TDS limit based on the results of the ecological risk assessment.

7.4.4 Long-Term Effectiveness and Permanence

Upgrades to the existing treatment plant using a sodium hydroxide neutralization/ precipitation process can provide effective long-term treatment of ARD at the Site. As discussed in Section 6 of this FFS, a 300-gpm treatment rate is expected to provide greater than 90 percent certainty that ARD generated at the Site could be treated prior to discharge. However, an improperly operated and maintained treatment plant and equipment could significantly reduce treatment efficiency allowing discharge of highly contaminated surface water to Strawberry Creek. Additionally, the sodium hydroxide N/P process has not been shown to be effective in TDS and selenium removal. Alternative 6a is considered highly effective in the long-term with an interim TDS and selenium ARAR waiver.



LEGEND

- Main Process Piping
- Solids/Residuals Piping
- Chemical Feed

CDM Federal Programs Corporation
A Subsidiary of Camp Dresser & McKee Inc.

FIGURE 7-2

ALTERNATIVE 6a
PROCESS FLOW DIAGRAM
SODIUM HYDROXIDE PRECIPITATION

GILT EDGE MINE
LAWRENCE COUNTY, SOUTH DAKOTA

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7.4.5 Reduction of Toxicity, Mobility, or Volume through Treatment

The EPA RI/FS guidance (EPA 1988) states that reduction of toxicity, mobility, or volume is only accomplished by treatment. Since Alternative 6a provides active treatment of ARD and can significantly reduce the toxicity and volume of contamination reaching Strawberry and Bear Butte Creeks, it is considered very highly effective in the reduction of toxicity, mobility, and volume of metals contamination migrating offsite.

7.4.6 Short-Term Effectiveness

Excavation, trenching, grading, and other activities associated with construction of the upgrades could cause short-term exposure to airborne and waterborne contamination; however, this exposure could be reduced through dust control/ suppression measures and hydraulic controls as well as proper use of appropriate levels of personal protective equipment during construction of Alternative 6a. As mentioned previously, the 300-gpm treatment capacity would provide for greater than 90 percent certainty that all ARD generated by surface water runoff on the Site could be treated prior to discharge. Alternative 6a can be constructed in a relatively short time frame providing the necessary ARD treatment. Therefore, Alternative 6a would be very highly effective in the short-term.

7.4.7 Implementability

The equipment and materials required for upgrades to the existing WTP are readily available and can be installed using conventional construction equipment. However, due to local climatic conditions, construction of the upgrades would need to occur during the construction season that typically runs from April through November of each year. Chemicals required for continuous operation of the WTP are also readily available in the local area and can be supplied to the Site in the quantities necessary. Sodium hydroxide N/P processes have been field proven for treatment of similar ARD streams. Proper O&M of the treatment plant would be required for effective ARD treatment. Overall, Alternative 6a would be considered highly implementable.

7.4.8 Cost

The estimated capital cost construction of Alternative 6a is $1,690,000. The annual O&M costs associated with operations and maintenance of the treatment plants and overall Site administration is $4,030,000. The total present worth cost for Alternative 6a is $9,789,000 (95 percent probability of dewatering the Site in less than 2.1 years). Spreadsheets in Appendix D summarize the cost elements of Alternative 6a.

7.5 Alternative 6b: Convert Existing Caustic Chemical Precipitation Treatment Plant to Lime Precipitation and Upgrade with Filtration

7.5.1 Description

Alternative 6b consists of converting the existing treatment plant to a lime N/P process with the addition of lime slaking and lime slurry chemical feed equipment and upgrades including a circular clarifier and filtration equipment for post sedimentation effluent polishing. The total treatment capacity of Alternative 6b would be 300 gpm. Solids produced by the process would be dewatered with a filter press and landfilled onsite. Final acid pH adjustment equipment would also be provided in the event that effluent pH requires adjustment to meet the discharge limit. However, pH adjustment is not currently required to meet the discharge limit. A process flow diagram for Alternative 6b is shown on Figure 7-3.

7.5.2 Overall Protection of Human Health and the Environment

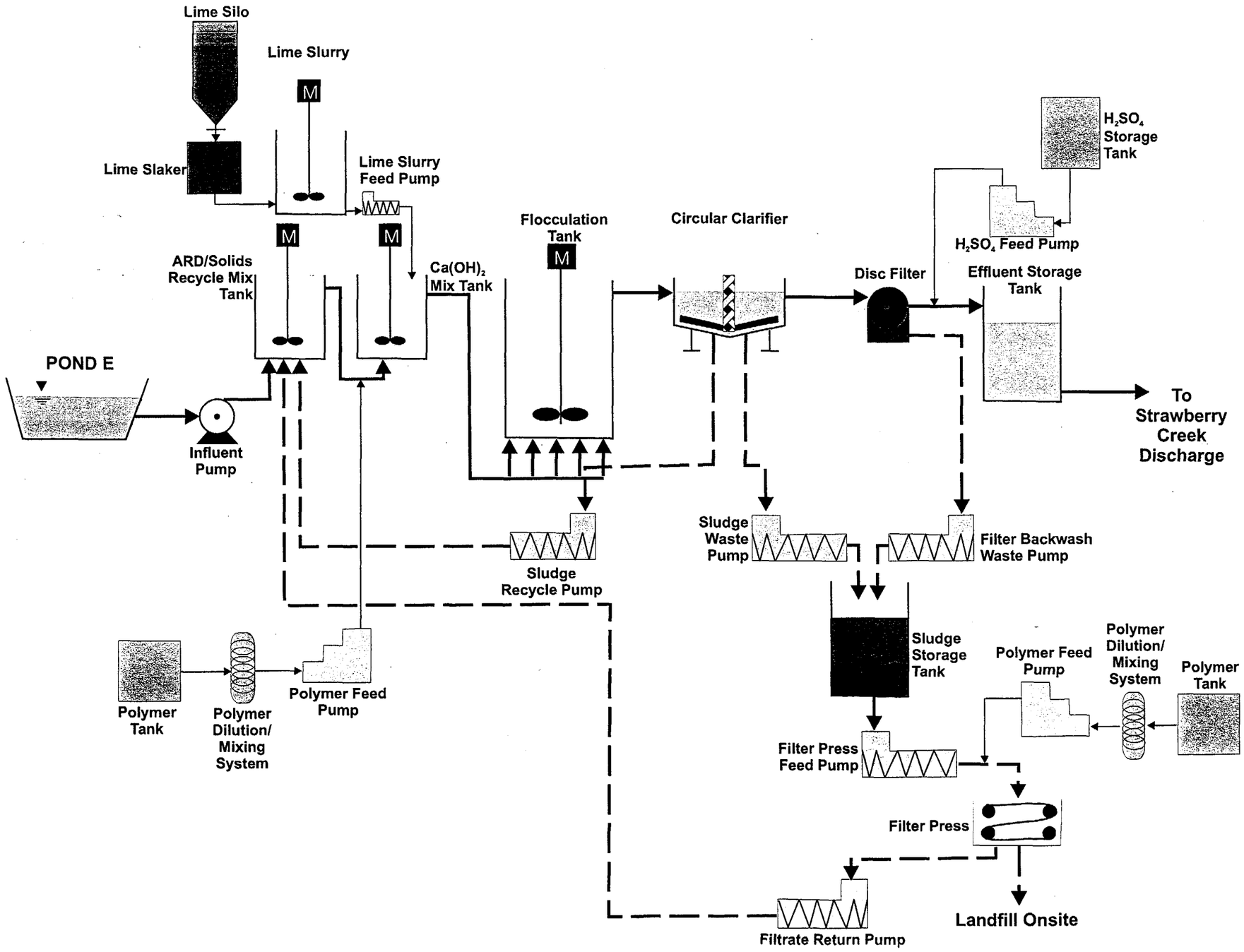
Alternative 6b would treat all of the ARD generated at the Site preventing any untreated discharge from the Site. The treatment provided by Alternative 6b would significantly reduce metals contamination and would raise discharge pH of surface water to the neutral range (6.0 to 9.0). Although the site specific selenium removal efficiency is unknown, and TDS reduction may not be below the ARAR limit, Alternative 6b is considered to be highly protective of human health and the environment.

7.5.3 Compliance with ARARs

Because Alternative 6b addresses all of the IRAGs outlined in paragraph 3.1 for surface water leaving the Site with the possible exceptions of TDS and selenium, and the design and construction will be in accordance with state, federal, and local requirements, it is determined to be highly effective in meeting ARARs with a TDS and selenium interim ARAR waiver or establishment of a higher TDS limit based on the results of the ecological risk assessment.

7.5.4 Long-Term Effectiveness and Permanence

The conversion of the existing caustic N/P plant to a lime N/P process can provide effective long-term treatment of ARD at the Site. As discussed in Section 6 of this FFS, a 300-gpm treatment rate is expected to provide greater than 90 percent certainty that ARD generated at the Site could be treated prior to discharge. However, an improperly operated and maintained treatment plant and equipment could significantly reduce treatment efficiency allowing discharge of highly contaminated surface water to Strawberry Creek. Additionally, it is uncertain whether the lime N/P process can remove TDS and selenium to below the ARAR limits. Alternative 6b is considered highly effective in the long-term with an interim ARAR waiver for TDS and selenium.



LEGEND

- Main Process Piping
- Solids/Residuals Piping
- Chemical Feed

CDM Federal Programs Corporation
A Subsidiary of Camp Dresser & McKee Inc.

FIGURE 7-3

ALTERNATIVE 6b
PROCESS FLOW DIAGRAM
LIME PRECIPITATION

GILT EDGE MINE
LAWRENCE COUNTY, SOUTH DAKOTA

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7.5.5 Reduction of Toxicity, Mobility, or Volume through Treatment

The EPA RI/FS guidance (EPA 1988) states that reduction of toxicity, mobility, or volume is only accomplished by treatment. Since Alternative 6b provides active treatment of ARD and can significantly reduce the toxicity and volume of contamination reaching Strawberry and Bear Butte Creeks, it is considered very highly effective in the reduction of toxicity, mobility, and volume of metals contamination migrating offsite.

7.5.6 Short-Term Effectiveness

Excavation, trenching, grading, and other activities associated with converting and upgrading the existing WTP could cause short-term exposure to airborne contamination; however, this exposure could be reduced through dust control/ suppression measures implemented during construction of Alternative 6b. As mentioned previously, the 300-gpm treatment capacity would provide for greater than 90 percent certainty that all ARD generated by surface water runoff on the Site could be treated prior to discharge. Alternative 6b can be constructed in a relatively short time frame providing the necessary ARD treatment. Therefore, Alternative 6b would be very highly effective in the short-term.

7.5.7 Implementability

The equipment and materials required for converting and upgrading the existing WTP to a lime process are readily available and can be installed using conventional construction equipment. However, due to local climatic conditions, construction of the plant upgrades and conversion would need to occur during the construction season that typically runs from April through November of each year. Chemicals required for continuous operation of the WTP are also readily available in the local area and can be supplied to the Site in the quantities necessary. Lime neutralization/ precipitation processes have been field proven for treatment of similar ARD streams. Proper O&M of the treatment plant would be required for effective ARD treatment. Overall, Alternative 6b would be considered highly implementable.

7.5.8 Cost

The estimated capital cost construction of Alternative 6b is $2,496,000. The annual O&M costs associated with operations and maintenance of the treatment plants and overall Site administration is $3,001,000. The total present worth cost for Alternative 6b is $8,527,000 (95 percent probability of dewatering the Site in less than 2.1 years). Spreadsheets in Appendix D summarize the cost elements of Alternative 6b.

7.6 Alternative 6c: Construct New 300-gpm Microencapsulation/Precipitation Treatment Plant

7.6.1 Description

Alternative 6c consists of constructing a new 300 gpm WTP using a proprietary microencapsulation/precipitation process. The total treatment capacity of Alternative 6c would be 300 gpm. Solids produced by the process would be landfilled onsite. A process flow diagram for Alternative 6c is shown on Figure 7-4. The new treatment plant would be located downstream of Pond E near the Strawberry Pond pumphouse.

7.6.2 Overall Protection of Human Health and the Environment

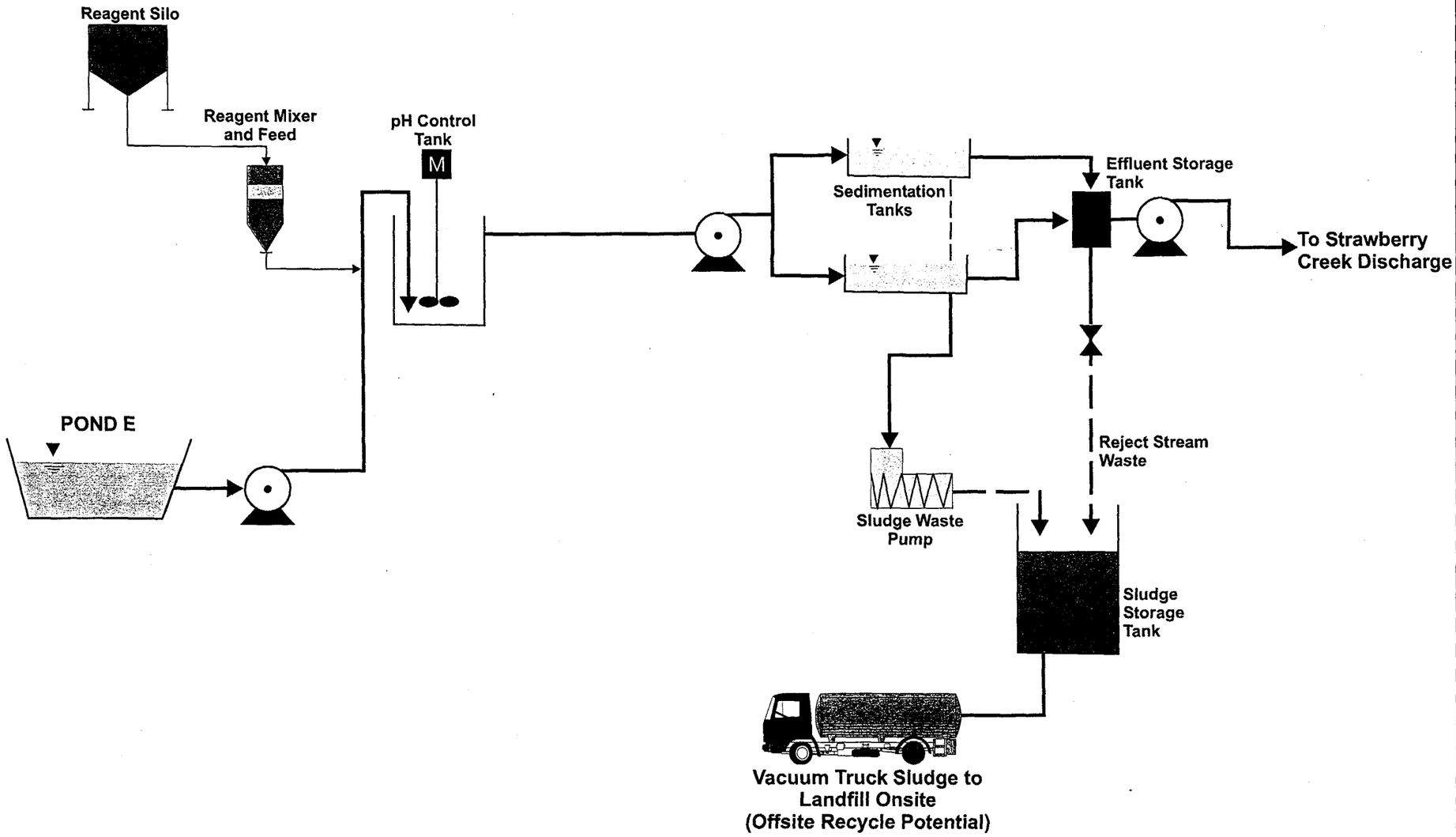
Alternative 6c would treat all of the ARD generated at the Site preventing an untreated discharge from the Site. The treatment provided by Alternative 6c would significantly reduce metals contamination including selenium and would raise pH of surface water leaving the Site to the neutral range (6.0 to 9.0). Since the treatment process will reduce TDS, but not necessarily below the ARAR limit, Alternative 6c is considered to be highly protective of human health and the environment.

7.6.3 Compliance with ARARs

Because Alternative 6c addresses all of the IRAGs outlined in paragraph 3.1 for surface water leaving the Site with the exception of TDS, and the design and construction will be in accordance with state, federal, and local requirements, it is determined to be highly effective in meeting ARARs with a TDS interim ARAR waiver or establishment of a higher TDS limit based on the results of the ecological risk assessment.

7.6.4 Long-Term Effectiveness and Permanence

The construction of a new microencapsulation precipitation process can provide effective long-term treatment of ARD at the Site. As discussed in Section 6 of this FFS, a 300-gpm treatment rate is expected to provide greater than 90 percent certainty that all ARD generated at the Site could be treated before discharge from the Site. However, an improperly operated and maintained WTP and equipment could significantly reduce treatment efficiency allowing discharge of highly contaminated surface water to Strawberry Creek. Additionally, the microencapsulation process is not anticipated to remove TDS to below the ARAR limit. Alternative 6c is considered highly effective in the long-term with an interim TDS ARAR waiver.



LEGEND

- Main Process Piping
- Solids/Residuals Piping
- Chemical Feed

CDM Federal Programs Corporation
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FIGURE 7-4

ALTERNATIVE 6c
PROCESS FLOW DIAGRAM
MICROENCAPSULATION/ PRECIPITATION

GILT EDGE MINE
LAWRENCE COUNTY, SOUTH DAKOTA

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7.6.5 Reduction of Toxicity, Mobility, or Volume through Treatment

The EPA RI/FS guidance (EPA 1988) states that reduction of toxicity, mobility, or volume is only accomplished by treatment. Since Alternative 6c provides active treatment of ARD and can significantly reduce the toxicity and volume of contamination reaching Strawberry and Bear Butte Creeks, it is considered very highly effective in the reduction of toxicity, mobility, and volume of metals contamination migrating offsite.

7.6.6 Short-Term Effectiveness

Excavation, trenching, grading, and other activities associated with construction of the new 300-gpm treatment plant could cause short-term exposure to airborne contamination; however, this exposure could be reduced through dust control/ suppression measures implemented during construction of Alternative 6c. As mentioned previously, the 300-gpm treatment capacity would provide for greater than 90 percent certainty that ARD generated by surface water runoff on the Site could be treated prior to discharge. Alternative 6c could not be designed or constructed until significant pilot testing is completed to determine process scale up design parameters. Therefore, Alternative 6c would be moderately effective in the short-term.

7.6.7 Implementability

The equipment and materials required for construction of the new WTP are readily available and can be installed using conventional construction equipment. However, due to local climatic conditions, construction of the new WTP would need to occur during the construction season that typically runs from April through November of each year. It is unknown if all of the chemicals required for the microencapsulation process are readily available in the local area and can be supplied to the Site in the quantities necessary at competitive prices. Additionally, application of microencapsulation to similar ARD waste streams is limited. Finally, independent verification process performance and anticipated chemical usage could not be obtained for the purposes of this FFS. Independent verification of process performance by pilot testing along with disclosure of process specifics under a non-disclosure agreement with proprietors is required to ensure effectiveness and implementability. Proper O&M of the treatment plant would be required for effective ARD treatment. Overall, Alternative 6c is considered moderately implementable.

7.6.8 Cost

The estimated capital cost construction of Alternative 6c is $1,985,000. The annual O&M costs associated with operations and maintenance of the treatment plants and overall Site administration is $3,332,000. The total present worth cost for Alternative 6c is $8,681,000 (95 percent probability of dewatering the Site in less than 2.1 years). Spreadsheets in Appendix D summarize the cost elements of Alternative 6c.

7.7 Alternative 6d: Construct New 300-gpm Optimized Chemical Precipitation WTP Using Proprietary Metals Coordination Process with Microfiltration and pH Adjustment

7.7.1 Description

Alternative 6d consists of constructing a new 300-gpm WTP using a proprietary metals coordination process with microfiltration and pH adjustment. The existing WTP would be decommissioned. The total treatment capacity of Alternative 6d would be 300 gpm. Solids produced by the process would be dewatered with a filter press and landfilled onsite. Potential exists to dispose of solids at an offsite metals recycling facility. A process flow diagram for Alternative 6c is shown on Figure 7-5. The new treatment plant would be located downstream of Pond E near the Strawberry Pond pumphouse.

7.7.2 Overall Protection of Human Health and the Environment

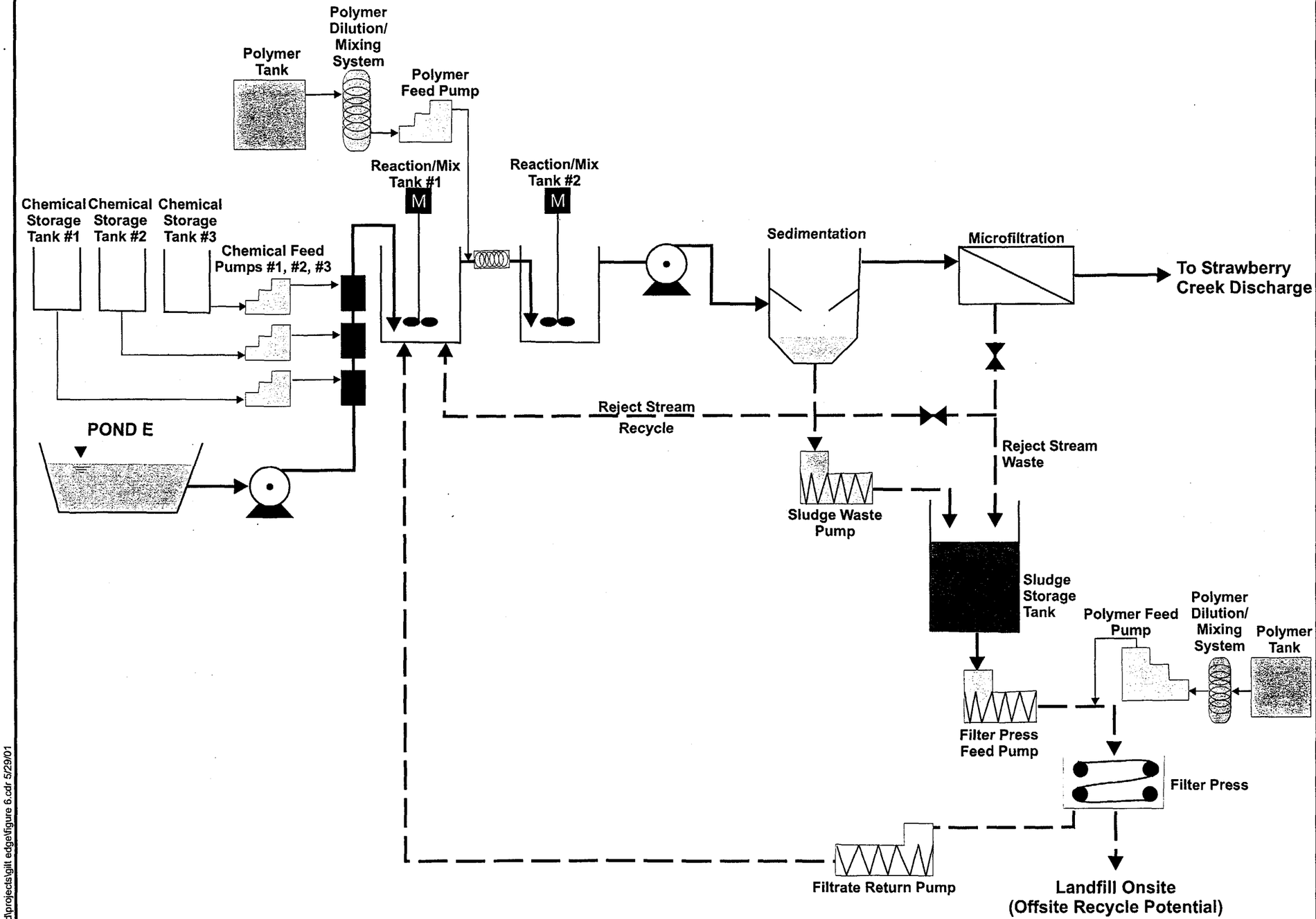
Alternative 6d would treat all of the ARD generated at the Site preventing an untreated discharge from the Site. The treatment provided by Alternative 6d would significantly reduce metals contamination including selenium and would raise pH of surface water leaving the Site to the neutral range (6.0 to 9.0). Since the treatment process will reduce TDS, but not necessarily below the ARAR limit, Alternative 6d is considered to be highly protective of human health and the environment.

7.7.3 Compliance with ARARs

Because Alternative 6d addresses all of the IRAGs outlined in paragraph 3.1 for surface water leaving the Site with the possible exception of TDS, and the design and construction will be in accordance with state, federal, and local requirements, it is determined to be highly effective in meeting ARARs with a TDS ARAR waiver or establishment of a higher TDS limit based on the results of the ecological risk assessment.

7.7.4 Long-Term Effectiveness and Permanence

The construction of a new metals coordination, microfiltration, and neutralization process can provide effective long-term treatment of ARD at the Site. As discussed in Section 6 of this FFS, a 300-gpm treatment rate is expected to provide greater than 92 percent certainty that all ARD generated at the Site could be treated before discharge from the Site. However, an improperly operated and maintained WTP and equipment could significantly reduce treatment efficiency allowing discharge of highly contaminated surface water to Strawberry Creek. Additionally, it is uncertain whether the proprietary metals coordination process can remove TDS to below the ARAR limits. Alternative 6d is considered highly effective in the long-term.



LEGEND

- Main Process Piping
- Solids/Residuals Piping
- Chemical Feed

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FIGURE 7-5

ALTERNATIVE 6d
PROCESS FLOW DIAGRAM
OPTIMIZED PRECIPITATION USING METALS COORDINATION

GILT EDGE MINE
LAWRENCE COUNTY, SOUTH DAKOTA

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7.7.5 Reduction of Toxicity, Mobility, or Volume through Treatment

The EPA RI/FS guidance (EPA 1988) states that reduction of toxicity, mobility, or volume is only accomplished by treatment. Since Alternative 6d provides active treatment of ARD and can significantly reduce the toxicity and volume of contamination reaching Strawberry and Bear Butte Creeks, it is considered very highly effective in the reduction of toxicity, mobility, and volume of metals contamination migrating offsite.

7.7.6 Short-Term Effectiveness

Excavation, trenching, grading, and other activities associated with construction of the new 300-gpm treatment plant could cause short-term exposure to airborne contamination; however, this exposure could be reduced through dust control/ suppression measures implemented during construction of Alternative 6d. As mentioned previously, the 300-gpm treatment capacity would provide for greater than 90 percent certainty that ARD generated by surface water runoff on the Site could be treated prior to discharge. Alternative 6d could not be designed or constructed until significant pilot testing is completed to determine process scale up design parameters. Therefore, Alternative 6d is considered moderately effective in the short-term.

7.7.7 Implementability

The equipment and materials required for construction of the new WTP are readily available and can be installed using conventional construction equipment. However, due to local climatic conditions, construction of the new WTP would need to occur during the construction season that typically runs from April through November of each year. It is unknown if all of the chemicals required for the metals coordination process are readily available in the local area and can be supplied to the Site in the quantities necessary. The metals coordination process has been applied to various metal waste streams in the semiconductor and mining industries at flow rates of 100 gpm to 4,000 gpm. However, application to similar ARD waste streams is limited. Additionally, independent verification of process performance could not be obtained for the purposes of this FFS. Independent verification of process performance by pilot testing along with disclosure of process specifics under a non-disclosure agreement with proprietors is required to ensure effectiveness and implementability. Proper O&M of the treatment plant would be required for effective ARD treatment. Overall, Alternative 6d is considered moderately implementable.

7.7.8 Cost

The estimated capital cost construction of Alternative 6d is $2,475,000. The annual O&M costs associated with operations and maintenance of the treatment plants and overall Site administration is $2,846,000. The total present worth cost for Alternative 6d is $8,195,000 (95 percent probability of dewatering the Site in less than 2.1 years). Spreadsheets in Appendix D summarize the cost elements of Alternative 6d.

7.8 Comparative Analysis

Table 7-1 represents a summary of the detailed analysis of alternatives.

Table 7-1 Summary of Detailed Analysis of Alternatives

Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume Through Treatment	Short-Term Effectiveness	Implementability	Present Worth Cost* (95% Probability)
1	Low	Low	Low	Low	Low	Very High	$476,000
3a	High	High	High	Very High	Very High	Very High	$266,000
3b	High	High	High	Very High	Very High	Very High	$311,000
6a	High	High	High	Very High	Very High	High	$9,789,000
6b	High	High	High	Very High	Very High	High	$8,527,000
6c	High	High	High	Very High	Moderate	Moderate	$8,681,000
6d	High	High	High	Very High	Moderate	Moderate	$8,195,000

* Cost spreadsheets are presented in Appendix D.

7.9 Conclusions

A comparative analysis of the retained alternatives indicates a range of present worth costs from $476,000 (Alternative 1) to $10,100,000 (Alternatives 3b and 6a) for the Site closure period. Selection of a treatment alternative should be based on the actual Site closure schedule and on an assessment of the costs and benefits of the treatment alternatives to protect human health and the environment at a minimum cost to Site closure. One each of Alternative 3 and Alternative 6 are required for selection.

Converting the existing caustic N/P plant to a lime process shows an overall cost savings of $1,262,000 over the Site dewatering time period of 2.1 years. However, since it is unlikely that the Site reclamation activities will be completed within the Site dewatering period, conversion to a lime precipitation process has the potential to provide additional cost savings. The simple payback period of the capital required to convert and upgrade the existing plant to a lime process is approximately 2.4 years.

Additional cost savings above that shown by conversion to a lime N/P process can be obtained by constructing a new treatment facility using the metals coordination process and decommissioning the existing WTP. However, because of the limited current application of this technology to similarly contaminated ARD waters and the proprietary nature of the process, extensive pilot testing would very likely be required to determine process design scale up parameters as well as true operational costs, waste stream characteristics (volume and composition), and process effectiveness.

Selection of any of the above alternatives as the preferred interim water treatment system will require pilot testing to determine process design scale up parameters including but not limited to chemical feed rates, sludge production rates, and sludge stability and dewatering characteristics.

Section 8
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Appendix A
Summary of Federal and State ARARs Compliance Operable Unit 2 Gilt Edge Mine NPL Site

APPENDIX A

SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

State and Regulation Citation	ARAR Determination	Description	Comment
		FEDERAL - Chemical Specific	
Safe Drinking Water Act, 42 U.S.C. § 300f, et seq., National Primary and Secondary Drinking Water Regulations 40 CFR 141 and 143	Relevant and Appropriate	The National Primary and Secondary Drinking Water Regulations (40 CFR 141 and 143) establish maximum contaminant levels (MCLs) for chemicals in drinking water distributed in public water systems. The primary standards are enforceable in South Dakota under the South Dakota Codified Law (SDCL) § 34A-3A-1, et seq., and Administrative Rules of South Dakota (ARSD) § 74:04:05.	Safe Drinking Water Act MCLs are relevant and appropriate to a Gilt Edge Mine OU2 remedial action because both influent and discharged water may infiltrate the aquifers found beneath the Gilt Edge mine site. This aquifer is currently a source for public water supplies. Additionally, the preamble to the National Contingency Plan (NCP) states that MCL's are relevant and appropriate for groundwater that is a current or potential source of drinking water. These standards may be applicable in the future should EPA detect an exceedence at a public water outlet.
Federal Surface Water Quality Requirements, Clean Water Act 33 U.S.C. §§ 1251, et seq.	Applicable	As provided under Section 303 of the Clean Water Act, 33 United States Code (U.S.C.) § 1313, the State of South Dakota has promulgated water quality standards.	Contaminated water emanating from the site will be intercepted and treated as part of OU2 - Interim Water Treatment pursuant to Federal and State Clean Water Act requirements.
National Ambient Air Quality Standards 40 CFR 50.6; (PM-10); 40 CFR 50.7 (PM 2.5); and 40 CFR 50.12 (Lead).	Relevant and Appropriate	These provisions establish standards for PM-10, PM 2.5, and lead emissions to air.	National ambient air quality standards (NAAQS) are implemented through the New Source Review Program and State Implementation Plans (SIPs). South Dakota has adopted the federal standards for particulate and lead emissions. State air quality standards are applicable and federal standards are relevant and appropriate. The Federal New Source Review program addresses only major sources. Emissions associated with proposed remedial action in OU2 will be limited to fugitive dust emissions associated with earth moving activities during construction, which will occur only in isolated areas over a short period of time and will have dust control mitigation measures implemented.

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APPENDIX A

SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

State and Regulatory Citation	ARAR Determination	Description	Comment
		STATE OF SOUTH DAKOTA - Chemical Specific	
Groundwater Quality Standards ARSD § 74:54:01	Applicable	This provision ARSD § 74:54:01 states that existing and future beneficial uses of groundwater shall be maintained and protected. Waters of the state in which ambient water quality is better than the minimum levels prescribed shall be maintained and protected at the better water quality. Groundwater that has an ambient concentration of 10,000 mg/L or less total dissolved solids (TDS) is classified as having the beneficial use of drinking water supplies suitable for human consumption.	Groundwater beneath the Gilt Edge site meets the established TDS requirements and the human consumption beneficial use must be restored and maintained. Contaminated water emanating from the site will be intercepted and treated as part of OU2 - Interim Water Treatment pursuant to Federal and State Clean Water Act requirements. As a result, groundwater resources down gradient from the site will be protected.
State of South Dakota Surface Water Quality Standards SDCL § 34A-2-11, et seq., and implementing regulations	Applicable	The Clean Water Act, 33 U.S.C. § 1251, et seq., provides the authority for each state to adopt water quality standards (40 CFR 131) designed to protect beneficial uses of each water body and requires each state to designate uses for each water body. Pursuant to this authority and the criteria established by the South Dakota regulations, SDCL § 34A-2-11, et seq., establishes requirements for restoring and maintaining the quality of surface and groundwater.	Contaminated water emanating from the site will be intercepted and treated as part of OU2 - Interim Water Treatment pursuant to Federal and State Clean Water Act requirements. As a result, surface water resources downstream from the site will be protected.

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SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

Statute and Regulatory Citation	ARAR Determination	Description	Comment
State of South Dakota Surface Water Quality Standards Effluent limitations for discharges to trout fishery waters ARSD § 74:51:01:32	Applicable	Effluents discharged from water pollution control facilities into waters classified for the beneficial use of coldwater permanent fish life propagation and coldwater marginal fish life propagation must be of high quality. In order to protect these uses, the effluent may not exceed 10 milligrams per liter (mg/L) of suspended solids and 10 mg/L of 5-day biochemical oxygen demand (BOD). The limit for suspended solids must be met at all times based on the results of a 24-hour composited sample. The limit for five-day BOD must be met at all times based on the results of any one 24-hour composited sample of the effluent. Neither pollution characteristic may exceed 17.5 mg/L in any one grab sample collected during the sampling period.	Bear Butte Creek above and below the Strawberry Creek confluence has been designated as a coldwater permanent fishery by the South Dakota Department of Game, Fish, and Parks

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APPENDIX A

SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

State and Regulatory Citation	ARAR Determination	Description	Comment
State of South Dakota Surface Water Quality Standards Anti Degradation Policy for Surface Waters of South Dakota ARSD § 74:51:01:34	Applicable	This provision establishes an anti-degradation policy for surface waters of South Dakota. The existing beneficial uses of surface waters of the state and the level of water quality that is assigned by designated beneficial uses shall be maintained and protected. Surface waters of the state in which the existing water quality is better than the minimum levels prescribed by the designated beneficial use shall be maintained and protected at that higher quality level. The State of South Dakota may allow a lowering of the water quality to levels established under the designated beneficial use if it is necessary in order to accommodate important economic or social development in the area in which the waters are located. Surface waters of the state which do not meet the levels of water quality assigned to the designated beneficial use shall be improved as feasible to meet those levels. No further reduction of water quality may be allowed for surface waters of the state that do not meet the water quality levels assigned to their designated beneficial uses as a result of natural causes or conditions, and all new discharges must meet applicable water quality standards. The State of South Dakota shall assure that regulatory requirements are achieved for all new and existing point sources and that nonpoint sources are controlled through cost effective and reasonable best management practices.	Surface water downstream of the Gilt Edge Site has a designated beneficial use as coldwater marginal fish life, propagation (Strawberry Creek), and coldwater permanent fishery (Bear Butte Creek above and below the Strawberry Creek confluence). Contaminated water emanating from this Site will be intercepted and treated as part of OU2 Interim Water Treatment pursuant to federal and state Clean Water Act requirements. As a result, beneficial uses of surface waters downstream from the site will be maintained.

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SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

Status and Regulatory Citation	ARAR Determination	Description	Comment
State of South Dakota Surface Water Quality Standards Beneficial Use for Waters of South Dakota ARSD § 74:51:01:42	Applicable	This provision establishes beneficial uses for waters of South Dakota. The beneficial use classifications of surface waters established do not limit the actual use of the waters. The classifications designate the minimum quality at which the surface waters of the state are to be maintained and protected. ARSD § 74:51:03:01 defines beneficial uses of South Dakota streams to include irrigation and fish and wildlife propagation, recreation, and stock watering. All streams in South Dakota are assigned the beneficial uses of irrigation and fish and wildlife propagation, recreation, and stock watering. The classifications only designate the quality at which the waters are to be maintained and protected. ARSD § 74:51:03:02 assigns additional beneficial uses to stream segments. Unless otherwise noted the entire course of a named stream is the segment with the designated use.	Surface water downstream of the Gilt Edge Site has a designated beneficial use as coldwater marginal fish life, propagation (Strawberry Creek), and coldwater permanent fishery (Bear Butte Creek above and below the Strawberry Creek confluence). Contaminated water emanating from this Site will be intercepted and treated as part of OU2 Interim Water Treatment pursuant to federal and state Clean Water Act requirements. As a result, beneficial uses of surface waters downstream from the site will be maintained.
State of South Dakota Surface Water Quality Standards Coldwater Marginal Fish Life Propagation Waters ARSD § 74:51:01:46	Applicable	Establishes criteria for coldwater marginal fish life propagation waters. The criteria of parameters for coldwater marginal fish life propagation waters and their allowable variations that are not included under § 74:51:01:55 and Appendix B, unless set under § 74:51:01:24. Special effluent limitations related to coldwater fisheries are established in ARSD § 74:51:01:32.	The South Dakota Department of Game, Fish, and Parks designates Strawberry Creek as a coldwater marginal fish life propagation water.

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APPENDIX A

SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

State and Regulatory Citation	ARAR Determination	Description	Comment
State of South Dakota Surface Water Quality Standards Limited Contact Recreation Waters ARSD § 74:51:01:51	Applicable	Criteria for limited contact recreation waters. The criteria of parameters for limited contact recreation waters and their allowable variations that are not included under § 74:51:01:55, unless set under § 74:51:01:24	The South Dakota Department of Game, Fish, and Parks designates Strawberry and Bear Butte Creeks as limited contact recreation waters
State of South Dakota Surface Water Quality Standards Fish and Wildlife Propagation, Recreation, and Stock Watering Waters ARSD § 74:51:01:52	Applicable	Criteria for fish and wildlife propagation, recreation, and stock watering waters. The criteria of parameters for fish and wildlife propagation, recreation, and stock watering waters and their allowable variations that are not included under § 74:51:01:55 and Appendix B, unless set under § 74:51:01:24.	The South Dakota Department of Game, Fish, and Parks designates all waters of the state as fish and wildlife propagation, recreation, and stock watering waters.
State of South Dakota Surface Water Quality Standards Irrigation Waters ARSD § 74:51:01:53	Applicable	Criteria for irrigation waters. The criteria of parameters for irrigation waters and their allowable variations that are not included under § 74:51:01:55 and Appendix B, unless set under § 74:51:01:24.	The South Dakota Department of Game, Fish, and Parks designates all waters of the state as irrigation waters.
State of South Dakota Surface Water Quality Standards Priority Pollutants and Chemicals ARSD § 74:51:01:55	Applicable	This provision establishes levels at which toxic pollutants are, or may become, injurious to public health, safety, or welfare; plant, aquatic, and animal life; or the existing or designated uses of waters may not be present in the surface waters of the state. The toxic pollutants to which this section applies are the priority pollutants and chemicals in 40 CFR Part 131 (July 1, 1995) and any other toxic pollutants or substances determined by the State of South Dakota to be of concern at a specific site.	Applicable to all waters of the state. Bear Butte and Strawberry Creek receive water from the site are considered waters of the state.

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APPENDIX A

SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

State and Regulatory Citation	ARAR Determination	Description	Comment
South Dakota Ambient Air Quality Standards ARSD § 74:36:02:02 and ARSD § 74:36:02:03	Applicable	South Dakota has adopted the federal standards for particulate (PM 10 and PM 2.5) and lead emissions. These standards apply to the entire State of South Dakota, and no person may cause these standards to be exceeded. These standards include normal background levels of air pollutants.	South Dakota has adopted the federal standards for particulate and lead emissions. Dust mitigation control measures will be implemented during construction activities.

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SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

Statute and Regulatory Citation	ARAR Determination	Description	Comment
		FEDERAL - Location Specific	
National Historic Preservation Act (NHPA), 16 U.S.C. § 470 40 CFR 6.301(b) 36 CFR 800	Applicable	This statute and implementing regulations require federal agencies to take into account the effect of this response action upon any district, site, building, structure, or object that is included in or eligible for the Register of Historic Places.	Archeological and cultural resource surveys and inventories were completed as part of the application process by Brohm Mining Company for a State Mining Permit for the Gilt Edge Mine. Pursuant to the State mining permit the State Historical Preservation Office has granted clearance for Gilt Edge Mine area of operations as having "No Adverse Affects" on cultural resources. Remedial activities will occur within the area of operations. If any remedial action activities are necessary beyond previously permitted and inventoried areas, SHPO consultation and NHPA compliance will be addressed during remedial design.
Archaeological and Historic Preservation Act 16 U.S.C. § 469 40 CFR 6.301(c)	Applicable	This statute and implementing regulations establish requirements for the evaluation and preservation of historical and archaeological data, which may be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program.	
Historic Sites, Buildings and Antiquities Act 16 U.S.C. § 461, et seq., 40 CFR 6.310(a)	Applicable	This statute and implementing regulations require federal agencies to consider the existence and location of land marks on the National Registry of National Landmarks and to avoid undesirable impacts on such landmarks.	
Fish and Wildlife Coordination Act 16 U.S.C. §§ 1531, et seq., 40 CFR 6.302(g)	Applicable	This statute and implementing regulations require that federal agencies or federally funded projects ensure that any modification of any stream or other water body affected by any action authorized or funded by the federal agency provides for adequate protection of fish and wildlife resources.	U.S. Fish and Wildlife is actively involved in this project and have approved all planned actions as being protective of fish and wildlife resources.
Endangered Species Act, 16 U.S.C. § 1531 40 CFR 6.302(h) 50 CFR 17 and 402	Applicable	This statute and implementing regulations provide that federal activities not jeopardize the continued existence of any threatened or endangered species.	EPA has consulted with representative of the U.S. Fish and Wildlife Service and South Dakota Dept. of Game, Fish & Parks to determine the existence of federal threatened or endangered species or state species of concern within the project area. These agencies have confirmed that this action will not impact or threaten such resources.

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SUMMARY OF FEDERAL AND STATE ARARs COMPLIANCE
OPERABLE UNIT 2
GILT EDGE MINE NPL SITE

Status and Regulatory Citation	ARAR Determination	Description	Comment
Floodplain Management Regulations 40 CFR 6.302(b), and Executive Order No. 11988.	Applicable	These require that actions be taken to avoid, to the extent possible, adverse effects associated with direct or indirect development of a floodplain, or to minimize adverse impacts if no practicable alternative exists.	The Flood Insurance Rate Map prepared by the Federal Emergency Management Agency for Lawrence County, South Dakota, indicates there are no flood hazard areas in the project area.
Protection of Wetlands Regulations 40 CFR 6, Appendix A, and Executive Order No. 11990.	Applicable	This ARAR requires federal agencies and the PRPs to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists. Wetlands are defined as those areas that are inundated or saturated by groundwater or surface water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.	Based on consultations with representatives of the U.S. Fish and Wildlife Service, South Dakota Dept. of Game, Fish & Parks, and the U.S. Army Corps of Engineers, there are no wetland areas that will be affected within or adjacent to the OU 2 area. However at this early phase of the project the presence and status of wetlands in the Strawberry Creek drainage is not resolved, making a finding of compliance with Wetlands Protection requirements for actions that may affect wetlands in the Strawberry Creek watershed premature.
Migratory Bird Treaty Act, 16 U.S.C. §§ 703, et seq.	Applicable	This requirement establishes a federal responsibility for the protection of the international migratory bird resource and requires continued consultation with the U.S. Fish and Wildlife Service during remedial design and remedial construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	EPA's consultation requirements are being met (1) through direct participation by U.S. Fish and Wildlife Service representatives on the inter-agency site investigation and remedial action planning and management team, and (2) through continued consultation during remedial design and remedial construction.
Bald Eagle Protection Act, 16 U.S.C. §§ 668, et seq.	Applicable	This requirement establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the U.S. Fish and Wildlife Service during remedial design and remedial construction to ensure that any cleanup of the site does not unnecessarily adversely affect the bald and golden eagles.	

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Statue and Regulatory Citation	ARAR Determination	Description	Comment
Federal Resource Conservation and Recovery Act (RCRA) Subtitle C Requirements 42 U.S.C. Section 9621, 40 CFR 264.18 (a) and (b)	**Not ARAR**	Federal hazardous waste regulations that restrict the location of new facilities. New facilities can not be located within 200 feet of a Holocene fault or within a 100-year floodplain.	This action is not related to the construction of a new hazardous waste treatment, storage, or disposal facility. Therefore the location standards are not ARARs. EPA reserves the right to address this ARAR should relocation of the water treatment plant result from the interim water treatment action at the site.

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Statue and Regulatory Citation	ARAR Determination	Description	Comment
STATE OF SOUTH DAKOTA - Location Specific			
Beneficial Use of Stream Segments of South Dakota Identified ARSD § 74:51:03:02.	Applicable	This provision establishes beneficial uses for waters of South Dakota. The beneficial use classifications of surface waters established do not limit the actual use of the waters. The classifications designate the minimum quality at which the surface waters of the state are to be maintained and protected. ARSD § 74:51:03:01 defines beneficial uses of South Dakota streams to include irrigation and fish and wildlife propagation; recreation, and stock watering. All streams in South Dakota are assigned the beneficial uses of irrigation and fish and wildlife propagation, recreation, and stock watering. The classifications only designate the quality at which the waters are to be maintained and protected.	Surface water downstream of the Gilt Edge Site has a designated beneficial use as coldwater marginal fish life, propagation (Strawberry Creek), and coldwater permanent fishery (Bear Butte Creek above and below the Strawberry Creek confluence). Contaminated water emanating from this Site will be intercepted and treated as part of OU2-Interim Water Treatment pursuant to federal and state Clean Water Act requirements. As a result, beneficial uses of surface waters downstream from the site will be maintained.
Segment Boundaries Described, ARSD § 74:51:03:03	Applicable	This provision designates the beneficial uses of specific sections of waters of South Dakota. Section, range, and township are used to describe the beginning or end point of a stream segment; the boundary of the segment is that point where the most downstream portion of the stream crosses the boundary of that section.	
The Belle Fourche River and Certain Tributaries' Use ARSD § 74:51:03:10	Applicable	This provision designates beneficial uses for the Belle Fourche River and certain tributaries.	One of the tributaries of the Belle Fourche River is Strawberry Creek. ARSD § 74:51:03:10 designates Strawberry Creek from Bear Butte Creek to Section 5, T 4 N, R 4 E as coldwater marginal fish life propagation waters and limited-contact recreation waters. Set criteria for Class 3 and Class 8 waters are established by ARSD § 74:51:01:46 and ARSD § 74:51:01:51, respectively.

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[illegible]	[illegible]	[illegible]	[illegible]
State of South Dakota Solid Waste Requirements; Location Standards ARSD § 74:27:07-17	Applicable	Sets forth location standards that all solid waste disposal sites must meet. These requirements apply to any person involved in any aspect of the management of solid waste, including recycling, processing, transporting, storing, or disposing of solid waste.	Applicable to an on-site disposal unit that would be constructed to contain waste materials generated by the OU2 remedial action.

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Clean Water Act Point Source Discharges Requirements 33 U.S.C. § 1342.	Relevant and Appropriate	Section 402 of the Clean Water Act, 33 U.S.C. § 1342, et seq., authorizes the issuance of permits for the "discharge" of any "pollutant." This includes stormwater discharges associated with "industrial activity." See 40 CFR 122.1 (b)(2)(iv). "Industrial ity"includes inactive mining operations that ge stormwater contaminated by contact with, or th s come into contact with any overburden, raw m al, inte diat ducts, fin produ yprod e pro located the sit such o ons, see 4 R 122.26 (b)(14 landfil nd application sites, and ope dump t recei have received an waste luding e subject to under Reso Conse on and Rec y Act (RCRA Su D, see 4 R 122.26(b (x).	Because the State of South Dakota has been delegated the authority to implement the Clean Water Act, these requirements are enforced in South Dakota through the South Dakota Surface Water Discharge System (SDSWD). Storm wa discharge t management practices will be imple ted durin medial action.

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State and Regulatory Citation	ARAR Determination	Description	Comment
Federal RCRA Subtitle C Requirements, 42 U.S.C. Section 9621, et seq. General Facility Standards 40 CFR 264 Subpart B Closure Requirements 40 CFR 264 Subpart G	Relevant and Appropriate	RCRA Subtitle C and implementing regulations are designated as applicable for any hazardous wastes that are actively "generated" as part of the Gilt Edge Mine OU2 site remedial action or that were "placed" or "disposed" after 1980. Also, should hazardous wastes be discovered as part of any remedial design or remedial action. The State of South Dakota has been delegated authority to implement the Federal RCRA Subtitle C and D programs. The State's RCRA [illegible] contain in State of South Dakota Solid Waste Requirements (SDCL § 34A-6), Hazardous Waste Requirements (SDCL § 34A-11), and Mined Land Reclamation Requirements (SDCL § [illegible] have been applied to the Brohm mine site through the State-issued mining permit. The substantive requirements of Brohm's permit (as amended) are applicable to this Superfund remedy.	RCRA Subtitle C requirements assumes that there will be many solid wastes at the Gilt Edge Mine OU2 site, and that some of these may be placed in "waste management areas" as a result of a remedial action. Because of the similarity of these waste management areas to the RCRA "waste management unit," certain discrete portions of the RCRA Subtitle C implementing regulations will be relevant and appropriate for the Gilt Edge Mine OU2 site remedial action. EPA will identify RCRA Subtitle C requirements in more detail at a later date.

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[illegible]	[illegible]	[illegible]	[illegible]
Federal RCRA Subtitle D Solid Waste Requirements: 40 CFR 257.3-1 40 CFR 257.3-2 40 CFR 257.3-3 40 CFR 257.3-4 40 CFR 257.3-8(d)	Relevant and Appropriate	40 CFR 257 establishes criteria under Subtitle D of the Resource Conservation and Recovery Act for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health or the environment. See 40 CFR 257.1(a). This part comes into play whenever there is a "disposal" of solid or hazardous waste from a "facility." "Disposal" is defined as "the discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into or on any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwater." 40 CFR 257.2. "Facility" means "any land and appurtenances thereto used for the disposal of solid waste." The State of South Dakota has been delegated authority to implement the Federal RCRA Subtitle C and D programs. The State's RCRA authorities are contained in State of South Dakota Solid Waste Requirements (SDCL § 34A-6), Hazardous Waste Requirements (SDCL § 34A-11), and Mined Land Reclamation Requirements (SDCL § 45-6B), and have been applied to the Brohm mine site through the State-issued mining permit. The substantive requirements of Brohm's permit (439 as amended) are applicable to this Superfund remedy.	Applicable to an on-site disposal unit that would be constructed to contain waste materials generated by the OU2 remedial action.

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Statute and Regulation Citation	ARAR Determination	Description	Comments
Surface Mining Control and Reclamation Act 30 U.S.C. §§ 1201-1326	Relevant and Appropriate	This Act and implementing regulations, 30 CFR 784 and 30 CFR 816, establish procedures to protect the environment form the effects of surface coal mining operations, and to a lesser extent, non-coal mining operations. These requirements are relevant and appropriate to the covering of discrete areas of contamination. The regulations require that revegetation be used to stabilize soil covers of discrete areas of contamination. They also require that revegetation be done according to a plan which specifies scheduling, species which are effective, planting methods, mulching techniques, irrigation if appropriate, and appropriate soil testing.	Reclamation performance standards are being developed by consultation with U.S. Fish and Wildlife Service, NCRS, South Dakota Dept. of Game, Fish, & Parks, SD State University, and SD DENR representatives. This standards will be included in the final remedy design.

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[illegible]	[illegible]	[illegible]	[illegible]
STATE OF SOUTH DAKOTA Action Specific			
Substantive SDSWD Permit Requirements ARSD § 74:52:01-11	Applicable	These provisions state that a discharge from any point source into surface waters may not occur without a valid State of South Dakota surface water discharge permit. Point sources requiring permits include industrial discharges and privately owned [illegible]ment works. Sites under CERCLA are required [illegible] the substantive requirements of a permit but [illegible]t have to actual obtain the permit.	All contaminated waters emanating from the Site are intercepted and treated as part of OU2 - Interim Water Treatment pursuant to Federal and State Clean Water Act requirements.

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Statue and Regulatory Citation	ARAR Determination	Description	Comment
Water Quality Statutes and Regulations ARSD § 74:51:01 Compliance with Criteria for Beneficial Use ARSD § 74:51:01:02 Restrictions for Water with Dual Classification ARSD § 74:51:01:03 Application of Criterion to Contiguous Waters ARSD § 74:51:01:04 Materials Causing Pollutants to Form in Water ARSD § 74:51:01:05 Visible Pollutants Prohibited ARSD § 74:51:01:06 Acids and Alkalis ARSD § 74:51:01:07 Taste- and Odor- Producing Materials ARSD § 74:51:01:08 Biological Integrity of Waters ARSD § 74:51:01:12	Applicable	A person may not discharge or cause to be discharged into surface waters of the state pollutants which cause the receiving water to fail to meet the criteria for its existing or designated beneficial use or uses. Sites under CERCLA are required to meet the substantive requirements of a permit but do not have to actual obtain the permit.	All contaminated waters emanating from the Site are intercepted and treated as part of Operable Unit 2 - Interim Water Treatment pursuant to Federal and State Clean Water Act requirements. Storm water discharge best management practices will be implemented during remedial action.

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Statue and Regulatory Citation	ARAR Determination	Description	Comment
Antidegradation of Waters of the State of South Dakota ARSD § 74:51:01 Beneficial Use Maintained and Protected ARSD § 74:51:01:34 Future Beneficial Use Maintained and Protected ARSD § 74:54:01:03	Applicable	The existing beneficial uses of surface waters of the state and the level of water quality that is assigned by designated beneficial uses shall be maintained and protected and the existing and future beneficial uses of groundwater shall be maintained and protected.	All contaminated waters emanating from the Site are intercepted and treated as part of Operable Unit 2 - Interim Water Treatment pursuant to Federal and State Clean Water Act requirements. Storm water discharge best management practices will be implemented during remedial action.
Surface Water Discharge ARSD § 74:52:01-11	Applicable	These provisions state that a discharge from any point source into surface waters may not occur without a valid State of South Dakota surface water discharge (SWD) permit. Point sources requiring permits include industrial discharges and privately owned treatment works, and stormwater associated with industrial activity. Sites under CERCLA are required to meet the substantive requirements of a permit but do not have to actual obtain the permit.	All contaminated waters emanating from the Site are intercepted and treated as part of Operable Unit 2 - Interim Water Treatment pursuant to Federal and State Clean Water Act requirements. Storm water discharge best management practices will be implemented during remedial action.

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Statue and Regulatory Citation	ARAR Determination	Description	Comment
State Hazardous Waste Management Requirements SDCL 34A-11 and corresponding rules ARSD § 74:28 Surface Impoundment Closure ARSD § 74:28:25:01 Waste Pile Closure ARSD § 74:28:25:01 Landfill Closure ARSD § 74:28:25:01	Relevant and Appropriate	All federal RCRA Subtitle C requirements for hazardous waste treatment, storage, and disposal facilities are incorporated by reference as State of South Dakota requirements as provided for under ARSD § 74:28:25:01 unless mentioned otherwise. Specific requirements have been referenced back to the State Hazardous Waste requirements for surface impoundment, waste pile, and landfill closure requirements. Federal and State RCRA Subtitle C requirements are both relevant to this action. State Hazardous Waste requirements were deemed more appropriate since the South Dakota Hazardous Waste program is authorized.	Mining waste at Gilt Edge is exempt from the State Hazardous Waste Management Act and RCRA Subtitle C under the Bevill exclusion. However if disposal activity involves the use of a waste management unit sufficiently similar to a Hazardous Waste regulated unit, and the unit is to receive wastes sufficiently similar to a hazardous waste, the RCRA Subtitle C requirement pertaining to that type of waste management unit would be relevant and appropriate (55 FR 8763)
State of South Dakota Solid Waste Requirements SDCL § 34A-6 Definitions SDCL § 34A-6-1.3 Facility Design and Construction ARSD § 74:27:12 Closure and Post-Closure ARSD § 74:27:15	Applicable	Sets forth standards that all solid waste disposal sites must meet. These requirements apply to any person involved in any aspect of the management of solid waste, including recycling, processing, transporting, storing, or disposing of solid waste. Rubble sites, construction demolition sites, restricted-use sites, nonmunicipal solid waste monofills, and other types of facilities not specifically listed must be designed and constructed to protect human health and prevent degradation of the environment, including ambient groundwater quality, surface water quality, and air quality.	The definition of solid waste includes sludge from a waste treatment plant. Facilities designed to contain this sludge produced by the OU2 treatment facility must comply with SDCL § 34A-6.

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Statue and Regulatory Citation	ARAR Determination	Description	Comment
South Dakota Mined Land Reclamation Act SDCL 45-6B, and ARSD § 74:29	Applicable	This act sets forth standards by which mine operators are to conduct reclamation of all affected lands. Certain discrete portions of the statutory or regulatory provisions are relevant and appropriate requirements. The definition of reclamation is the employment during and after a mining operation of procedures to minimize the disruption from the mining operation and to provide for the rehabilitation of the affected land through the rehabilitation of plant cover, soil stability, water resources, or other measures appropriate to the subsequent beneficial use of the mined and reclaimed lands.	EPA's consultation with SD DENR during remedial design development will have satisfied this requirement.
Noxious Weeds ARSD § 12:62:03, et seq.	Applicable	ARSD § 12:62:03:01.06 lists weeds which are declared to be noxious statewide. A locally noxious weed is defined as any weed that is biennial, perennial, or a pernicious annual, capable of spreading rapidly, not controllable without special preventive chemical, mechanical, biological, and cultural practices, capable of materially reducing the production of crops or livestock, and capable of decreasing the value of the land. ARSD § 12:62:03:01.07 lists weeds that may be declared locally noxious.	A revegetation plan is being developed by EPA with consultation from U.S. Fish and Wildlife Service, USDA National Resource Conservation Service (with local and county coordination), South Dakota Dept. of Game, Fish, & Parks, SD State University, and SD DENR representatives. The revegetation plan will be included in the final remedy design.

observed data from operations at the site during the 1999 water year (10/1/99 to 10/1/00). The comparison of primary input parameters and results is shown in Table 15.

The WMC report (1999) estimated that a net positive balance of approximately 74,189,400 gallons occurs under average annual flow conditions based on an annual average precipitation depth of 25 in. In general, they concluded that management of average annual inflows to the site is feasible by operating the water treatment plant continuously (at a clean water outflow of approximately 200 gpm).

Results of the stochastic model using and annual precipitation depth of 25 in. showed a net positive balance of approximately 75,869,200 gallons. This estimate is only 2% higher than the WMC estimate.

The stochastic model provides a slightly more conservative estimate of runoff amounts and the water balance (slightly more runoff and water accumulation) than the WMC estimate. The primary reason for this difference is the variable amounts of ET and infiltration loses (to groundwater) for different areas of the site used in the WMC water balance. The difference of 2% is considered an excellent validation of the stochastic model.

A simple water balance (Table 16) for the site for the 1999 water year (10/1/99 to 10/5/00) based on measured precipitation amounts and WTP flowrates was also performed and compared to results using the stochastic model (Table 15). The total precipitation measured at the Lead, South Dakota Homestake Mine station was 28.72 in. During this time, approximately 107,500,000 gallons were treated at the WTP (annual average WTP rate of approximately 205 gpm). This includes all runoff and 9,894,000 gallons dewatered from the King shaft. Results of the water balance indicated that runoff was 98,427,851 gallons.

Using an annual precipitation depth of 28.72 in., the stochastic model showed runoff of approximately 101,018,000 gallons. This is approximately 3% higher than the estimated runoff based on observed data from the site during the 1999 water year. The difference of 3% is considered a good validation of the stochastic model based on only one year of data.

Predictive Charts using the Simple Water Balance and Various Water Treatment Rates

Various ARD dewatering scenarios can be presented by varying precipitation and ARD treatment rates input into the 1999 water year balance. Precipitation and ARD treatment rates projected into the future are shown in relation to various site closure options. Twenty-four (24) site ARD dewatering scenarios have been developed and are presented in the charts. Chart 1a, 2a, 3a, through 12a a show site ARD dewatering based on the 1999 precipitation. Chart1b, 2b, 3b, through 12b show site ARD dewatering based on 1999 precipitation plus two (2) wet years occurring back to back (2002 and 2003).

Chart 1a through Chart 6b shows dewatering scenarios based on treating all ARD water in storage at the site. Chart 7a through 12b shows dewatering scenarios based on treating only ARD water stored in the Sunday Pit in addition to ARD generated throughout the site by monthly precipitation. This treatment scenario was considered since ARD water present in the Anchor Hill Pit is being treated using an innovative treatment technology. If this treatment technology is successful, 73 million gallons of ARD in storage could be dischargeable from the site. Results for the Anchor Hill Pit Lake treatability study will not be available until early 2002.

The following explains the labels, titles, and symbols for the simple water balance charts:

Title Block — The title block explains the overall scenario being depicted on the chart in accordance with the following options [options are numbered 1), 2), etc.]:

A. Total Water Treatment Rate: 1) 200 gpm, 2) 250 gpm, or 3) 350 gpm
B. ARD to be Treated: 1) all ARD onsite or 2) Sunday Pit ARD only
C. Changes in Operations: 1) no operation changes, 2) addition of filter press (addition 50 gpm removed), or 3) additional plant capacity, additional 100 gpm removed
D. Other Site Closure Impacts: 1) No Ruby Flow Reduction, 2) Ruby Residual Flowing of 15 gpm
E. Chart Number: 1) 1a through 12a (1999 precipitation), or 2) 1b through 12b (1999 precipitation plus two wet years)
F. Actual ARD Removal Rate: 1) 16 gpm, 2) 66 gpm, or 3) 166 gpm (note: this is the amount of ARD being removed from storage)

Top Horizontal Axis — The top horizontal axis displays the chart timeline (water years) from 1999 to 2005 with notes showing the assumed time that site operations or closure activities are initiated/completed. The notes used on the charts are further explained below:

Site Operation/Closure Notes designated on Project Timelime:

A. Sunday Pit Only (dewatering time if only Sunday Pit ARD is treated)
B. 1st Wet Year (95 percentile water year used)
C. Early Action – 50 gpm (additional 50 gpm ARD removal from filter press)
D. WTP – 350 gpm (350 gpm treatment plant goes on-line)
E. LDPE Lay-Down (Ruby Cap remedy commences)
F. Ruby – Variable gpm (Reduced ARD generation from Ruby Cap remedy)
G. 2nd Wet Year (95 percentile water year used)
H. King Shaft (Proposed remedial activities at the King Shaft)
I. Dakota Maid/Sunday Pit (Proposed remedial activities at Dakota Maid/ Sunday Pit)
J. Anchor Hill (Proposed remedial activities at Anchor Hill)

Bottom Horizontal Axis — The bottom horizontal axis displays the months and years of the water balance timeline from October 1999 to September 2005.

Left Vertical Axis — The left vertical axis is the scale that shows the volume of ARD in storage in units of gallons. The bars on the chart represent the volume of ARD in storage and should be read off of this axis.

Right Vertical Axis — The right vertical axis is the scale that shows the assumed monthly precipitation in units of inches. The diamond symbols on the chart represent the monthly precipitation in inches and should be read off of this axis.

The following gives a brief interpretation of the simple water balance charts:

Treat All ARD Waters (Chart 1a through Chart 6b)

Chart 1a – With no changes to the current operation and no Ruby flow reduction, only 8.8 million gallons of ARD are removed from storage on a yearly basis. This treatment scenario does not meet the site-wide remediation schedule.

Chart 1b – With two wet years back to back, this treatment scenario shows that ARD dewatering occurs much later and does not meet the site-wide remediation schedule.

Chart 2a – With the addition of a filter press (additional 50 gpm treatment rate) and no Ruby flow reduction, the site can be dewatered in January 2005. However, approximately 25 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario does not meet the site-wide remediation schedule.

Chart 2b – With two wet years back to back, this treatment scenario shows that ARD dewatering occurs much later and does not meet the site-wide remediation schedule.

Chart 3a – With the addition of a 100 gpm treatment and no Ruby flow reduction, the site can be dewatered in August 2003. Because of the increase treatment capacity, only 17 million gallons of ARD storage would be required to accommodate spring runoff and summer storms. This treatment scenario meets the site-wide remediation schedule.

Chart 3b – With two wet years back to back, this scenario shows that the site can be dewatered in November 2003. Although an additional three months of water treatment is required, this treatment scenario still meets the site-wide remediation schedule.

Chart 4a – Shows the impact of capping the Ruby Dump and no changes to the current operation. Although more ARD is removed from storage when compared to Chart 1a,

this treatment scenario still does not dewater the site nor meet the site-wide remediation schedule.

Chart 4b – With two wet years back to back, this treatment scenario shows that ARD dewatering occurs much later and does not meet the site-wide remediation schedule.

Chart 5a – Shows the impact of capping the Ruby Dump and the addition of a filter press (additional 50 gpm treatment rate). The site can be dewatered in February 2004 versus January 2005 (Chart 2a). Approximately 20 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario meets the site-wide remediation schedule.

Chart 5b – With two wet years back to back, this treatment scenario shows that the site can be dewatered in November 2004. Because of the delay in dewatering the site, this treatment scenario does not meet the site-wide remediation schedule.

Chart 6a – Shows the impact of capping the Ruby Dump and the addition of a 100 gpm treatment. The site can be dewatered in July 2003 versus August 2003. Because of the increase treatment capacity, only 11 million gallons of ARD storage would be required to accommodate spring runoff and summer storms. This treatment scenario meets the site-wide remediation schedule.

Chart 6b – With two wet years back to back, this scenario shows that the site can be dewatered in October 2003. Although an additional three months of water treatment is required, this treatment scenario still meets the site-wide remediation schedule.

Treat Sunday Pit ARD Water Only (Chart 7a through Chart 12b)

Chart 7a – With no changes to the current operation and no Ruby flow reduction, the Sunday Pit cannot be dewatered in accordance with remediation schedule.

Chart 7b – With two wet years back to back, this treatment scenario shows that ARD dewatering of the Sunday Pit occurs much later and does not meet the Sunday Pit remediation schedule.

Chart 8a – With the addition of a filter press (additional 50 gpm treatment rate) and no Ruby flow reduction, the Sunday Pit can be dewatered in January 2003. Approximately 25 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 8b – With two wet years back to back, this treatment scenario shows that dewatering of the Sunday Pit occurs in December 2003. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 9a – With the addition of a 100 gpm treatment and no Ruby flow reduction, the Sunday Pit can be dewatered in October 2002. Because of the increase treatment capacity, only 17 million gallons of ARD storage would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 9b – With two wet years back to back, this scenario shows that the Sunday Pit can be dewatered in November 2002. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 10a – Shows the impact of capping the Ruby Dump and no changes to the current operation. The Sunday Pit can be dewatered in December 2003. Approximately 25 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 10b – With two wet years back to back, this treatment scenario shows that ARD dewatering of the Sunday Pit occurs in November 2004. Because of the delay in dewatering the Sunday Pit, this treatment scenario does not meet the Sunday Pit remediation schedule.

Chart 11a – Shows the impact of capping the Ruby Dump and the addition of a filter press (additional 50 gpm treatment rate). The Sunday Pit can be dewatered in December 2002. Approximately 20 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 11b – With two wet years back to back, this treatment scenario shows that the Sunday Pit can be dewatered in September 2003. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 12a – Shows the impact of capping the Ruby Dump and the addition of a 100 gpm treatment. The Sunday Pit can be dewatered in October 2002. Approximately 11 million gallons of ARD storage would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 12b – With two wet years back to back, this scenario shows that the Sunday Pit can be dewatered in November 2002. This treatment scenario meets the Sunday Pit remediation schedule.

References

U.S. Department of Commerce. 1979. Climatic Atlas of the United States.

Water Management Consultants. 1999. Gilt Edge Mine Priority 1 and Priority 2 Site Water Management Report.

Appendix B
Conceptual Cost Estimates for Interim ARD Treatment Alternative Scenarios

CDM Camp Dresser & McKee Inc.
Preliminary Opinion of Probable Cost

Project: *Gilt Edge Mine*
Project #: *4000-30291*
Location: *Lawrence County, South Dakota*

Updated: *7-Jun-01*
Estimator: *BCD/KO*
Project Status: *Final FFS (-30% to +50%)*

Table B-1. Summary of Alternative Treatment Scenarios

Alternative		Capital Cost	Annual O&M Cost	Present Worth Cost [1]	% Difference of Minimum Alternative Cost
A	Alternative 1 - No Action[2]	*0*	*241,000*	*310,000*	--
B	Alternative 3a - Divert ARD Flow from Hoodoo Gulch to Sunday Pit and Install ARD Diversion Ditch At Pond C	*262,000*	*1,900*	*264,000*	--
C	Alternative 3b - Divert ARD Flow from Hoodoo Gulch to Strawberry Pond and Install ARD Diversion Ditch At Pond C	*307,000*	*1,500*	*309,000*	--
D	Alternative 4a - Follow Existing Chemical Precipitation with Membrane Filtration (300 gpm)	*6,624,000*	*5,126,000*	*16,926,000*	*138%*
E	Alternative 5a - New ARD WTP with Caustic Addition, Chemical Precipitation, and Membrane Filtration (375 gpm)	*9,295,000*	*5,858,000*	*16,743,000*	*136%*
F	Alternative 5b - New ARD WTP with Lime Addition, Chemical Precipitation, and Membrane Filtration (375 gpm)	*7,894,000*	*3,835,000*	*12,770,000*	*80%*
G	Alternative 5f - New ARD WTP Including Anaerobic Sulfate Reduction, Metal Sulfide/Carbonate Precipitation and Partial Stream Membrane Filtration (375 gpm)	*8,302,000*	*4,215,000*	*13,661,000*	*92%*
H	Alternative 5g - New ARD WTP with Proprietary Microencapsulation/Precipitation and Partial Stream Membrane Filtration (375 gpm)	*4,146,000*	*5,246,000*	*10,816,000*	*52%*
I	Alternative 5h - New ARD WTP with Optimized Chemical Precipitation Using Proprietary Metals Coordination Process, and Partial Stream Membrane Filtration (375 gpm)	*4,668,000*	*4,208,000*	*10,018,000*	*41%*
J	Alternative 6a - Upgrade Existing Caustic Chemical Precipitation ARD WTP With Additional Treatment Train and Filtration (ARAR waiver) (375 gpm)	*1,860,000*	*4,341,000*	*7,379,000*	*4%*
K	Alternative 6b - Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Precipitation and upgrade With Additional Treatment Train and Filtration (ARAR waiver) (375 gpm)	*3,248,000*	*3,032,000*	*7,103,000*	*Min. Alt*
L	Alternative 6c - Construct New Proprietary Microencapsulation/Precipitation ARD WTP (ARAR Waiver) (375 gpm)	*2,583,000*	*4,010,000*	*7,681,000*	*8%*
M	Alternative 6d - Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (ARAR Waiver) (375 gpm)	*3,928,000*	*2,776,000*	*7,457,000*	*5%*

Notes:

(1) Present Worth analyis assumes annual O&M costs over period of time (years) required to de-water the site's water storage at a certain flow rate (250 gpm to 800 gpm)

Probability of de-watering the site (90, 95 or 99%) =	95
Treatment Capacity (gpm, increments of 100) =	400
Years required to de-water site (90%) =	0.8
Years required to de-water site (95%) =	1.3
Years required to de-water site (99%) =	--

(2) The No Action alternative annual O&M costs include the cost of one 5 -Year Review Report; Present Worth analysis is based on Annual O&M costs plus present worth of 5-Year Review Report in year 5.

Notes

1 PW - previous work; VQ - vendor quote (adjusted for labor and equipment as a percentage of material costs): 25%

2 Materials will be disposed of on-site; cost incurred for loader and truck.

3 Existing WTP is optimized to treat 300 gpm (including sludge dewatering equipment); water quality is assumed to be reflective of average values.

4 Estimated costs are for an additional 100 gpm treatment train to incrase the capacity to 375 gpm.

5 Annual O&M costs are estimated using CDM FPC labor rates and breakdown of ODC/IDC based on previous work.

6 Electrical utility costs currently are $0.0437/kWhr. FFS costs based on hours of operation and adjusted by 50 percent to $0.0655/kWhr.

7 Capital costs for the following items are estimated as a percentage of total Process/Mechancial costs:

Electrical	12%	for Alts 3a and 3b -	40%
Instrumentation and Controls	15%		20%

8 Material costs received from vendor quotes adjusted by 25% for labor and equipment to install.

9 Annual O&M costs also include snow removal equipment (Items 2.5.2.1 and 2.5.2.2) and labor (Item 2.3).

10 Valves and appurtenances are estimated as a percentage of the total piping costs, excluding gas line: 60%

11 HDPE pipe will be used for buried pipes; costs are estimated based on the excavation, bedding, and backfill/compaction.

12 Construction Prorates:

General Conditions (Overhead)[a]	20%
Contractor's Profit[b]	10%
Scope and Bid Design Contingency[c]	20%
Adjusted conversion	58.4%

(a) General conditions includes cost associated with permits, licenses, insurance, bonds, environmental safe guards, sediment and drainage control, and special construction practices to maintain continued plant operations.

(b) Contractor's overhead and profit include costs for mobilization/demobilization, administration, and contractor/subcontractor overhead costs and profits.

(c) A 20 percent design contingency was used for this estimate based on the conceptual nature of the information developed for this analysis.

13 Engineering Cost Factor:

The capital costs include the construct costs for the following items*:

Remedial Design	8%
Project Management	5%
Construction Management	6%
Total	19.0%

* for annual O&M, Technical Services (TS) included as Item 2.4 as a variance from *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA, 2001); Construction Management costs incorporated as prorate.

14 Gas costs estimated as a function of gas required to heat wastestream; $0.02/gpm.

15 Estimates received from MSD Gas Co., Rapid City, South Dakota.

16 Engineering and Construction Prorates are not applied to Item 1.3.2; costs include materials and installation of proprietary process train.

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

A **Alternative 1 - No Action(2)**

The No Action alternative would discontinue the currently existing surface water and dump ARD collection and treatment measures. There would be no change in the aqueous contaminant concentrations because no treatment, containment, or removal of ARD is included in this alternative.

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	**CAPITAL COSTS**			**Total**	**0**	
2	**ANNUAL COSTS**					
2.1	SAMPLING (inc. lab support)	1	LS	26,994	*27,000*	
2.2	STAFF					
2.2.1	Security	2	annual salary	34,200	*69,000*	Note 5
2.3	INDIRECT COSTS					
2.3.1	Radio and Pager Rental	1	LS	2,000	*2,000*	Note 5
2.3.2	Vehicles					
2.3.2.1	Pickup Truck	1	per year	9,000	*9,000*	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.3.2.2	Fuel	12	months	1,176	*15,000*	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.3.3	Utilities					
2.3.3.1	Water	12	months	100	*2,000*	Note 5
2.3.3.2	Phone	12	months	200	*3,000*	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.3.3.3	Electrical	12	months	200	*3,000*	Estimated
	Annual O&M Costs			**Subtotal**	**130,000**	
2.4	CONSTRUCTION PRORATES	1	LS	77,000	*77,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	26,000		
	Contractor's Profit[b]		10% of Total Cost + GC	16,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	35,000		
2.5	ENGINEERING COSTS (Construction Management only)	1	LS	13,000	*13,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	13,000		
	ANNUAL O&M COST			**Total**	**220,000**	
3	**PERIODIC COSTS**					
3.1	Five-Year Review Reports	1	LS	11,000	*11,000*	
3.2	CONSTRUCTION PRORATES (Contingency only)	1	LS	9,000	*9,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	3,000		
	Contractor's Profit[b]		10% of Total Cost + GC	2,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	4,000		
3.3	ENGINEERING COSTS (Construction Management only)	1	LS	1,000	*1,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	1,000		
				Total	**21,000**	

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

B Alternative 3a - Divert ARD Flow from Hoodoo Gulch to Sunday Pit

The seepage from Hoodoo Gulch would be collected within a collection system (sump) prior to convergence with Strawberry Creek. Collected water would gravity-fed to a storage tank and subsequently pumped to Sunday Pit. A HDPE lined diversion trench would be routed along Pond C and route ARD seepage to Pond D. The routing of Hoodoo Gulch surface flow to the WTP via Sunday Pit would ensure effective treatment to reduce the contaminant concentrations of effluent to Strawberry Creek. This alternative would be chosen along with an upgrade to the existing WTP or new WTP construction alternative.

Cumulative seepage flow rate, gpm = 10 gpm

Transfer flow rate, gpm = 30 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Sumps (hoodoo Gulch)	*5 total*				
1.1.1.1	Excavation	5	CY	52	1,000	Means Heavy Construction Cost Data (2001), 02240-500-0300
1.1.1.2	Backfill	4	CY	22	1,000	Means Heavy Construction Cost Data (2001), 02315-100-0300
1.1.2	Pond C Collection Ditch					
1.1.2.1	Excavation	500	CY	4.05	3,000	Means Heavy Construction Cost Data (2001), 02315-900-0050
1.1.2.2	Compaction	500	CY	2.71	2,000	Means Heavy Construction Cost Data (2001), 02315-900-1900
1.1.2.3	Trimming	8625	SF	0.42	4,000	Means Heavy Construction Cost Data (2001), 02315-900-2100
1.1.3	Piping (Trenching, Backfill, and Bedding)					
1.1.3.1	Sump Collectors	350	LF	3.57	2,000	Means Heavy Construction Cost Data (2001), 02315-940-0700, -1700, and -130-0200
1.1.3.2	Main Collector	900	LF	3.57	4,000	Means Heavy Construction Cost Data (2001), 02315-940-0700, -1700, and -130-0200
1.1.3.3	Transfer to Sunday Pit	2300	LF	2.05	5,000	Means Heavy Construction Cost Data (2001), 02315-940-3100 (adjusted by 20%) and -130-0200
				Subtotal	*22,000*	
1.2	STRUCTURAL					
1.2.1	Concrete Sump	5	EA	1,054	6,000	Means Heavy Construction Cost Data (2001), 02630-200-0800
1.2.1.1	HDPE Liner for Sump	250	SF	7.67	2,000	Means Heavy Construction Cost Data (2001), 02660-400-0200 and $60/hr at 5hrs per sump
1.2.2	HDPE Lining for Pond C Collection Ditch	10875	SF	1.05	12,000	Means Heavy Construction Cost Data (2001), 02630-400-0200
1.2.3	Concrete Foundation for Storage Tank	3	CY	161	1,000	Means Heavy Construction Cost Data (2001), 03300-130-4050
				Subtotal	*21,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Piping					
1.3.1.1	CPVC - 1" (Sump Discharge)	350	LF	2.45	1,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2100
1.3.1.2	CPVC - 2" (Main Collection Header)	900	LF	4.65	5,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2120
1.3.1.3	CPVC - 3" (Transfer to Sunday Pit)	2300	LF	9.10	21,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2160
1.3.1.4	Valves and Appurtenances	1	LS	16,000	16,000	Note 10
1.3.2	Storage Tank	1	LS	10,000	10,000	VQ
1.3.3	Submersible Pump	1	EA	4,500	5,000	VQ
				Subtotal	*58,000*	
1.4	ELECTRICAL	1	LS	24,000	*24,000*	Note 7
1.5	INSTRUMENTATION and CONTROLS	1	LS	12,000	*12,000*	Note 7
	Capital Costs			**Subtotal**	**137,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.6	CONSTRUCTION PRORATES	1	LS	82,000	*82,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	28,000		
	Contractor's Profit [b]		10% of Total Cost + GC	17,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	37,000		
1.7	ENGINEERING COSTS	1	LS	43,000	*43,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	18,000		
	Project Management		5% of Total Cost + Const Prorates	11,000		
	Construction Management		6% of Total Cost + Const Prorates	14,000		
	CAPITAL COST			**Total**	**262,000**	
2	**ANNUAL COSTS**					
2.1	ARD Transfer rom Hoodoo Gulch Seepage Storage Tank to Sunday Pit (at 8 hrs/day)	5	HP	429/(HP*yr)	*1,000*	Note 6
	Annual O&M Costs			**Subtotal**	**1,000**	
2.2	CONSTRUCTION PRORATES	1	LS	700	*700*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	200		
	Contractor's Profit [b]		10% of Total Cost + GC	200		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	300		
2.3	ENGINEERING COSTS (Construction Management only)	1	LS	200	*200*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	200		
	ANNUAL O&M COST			**Total**	**1,900**	

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

C **Alternative 3b - Divert ARD Flow from Hoodoo Gulch to Strawberry Pond**

The seepage from Hoodoo Gulch would be collected within a collection system (sump) prior to convergence with Strawberry Creek. Collected water would gravity-fed to a storage tank and subsequently pumped to Sunday Pit. A HDPE lined diversion trench would be routed along Pond C and route ARD seepage to Pond D. The routing of Hoodoo Gulch surface flow to the WTP via Sunday Pit would ensure effective treatment to reduce the contaminant concentrations of effluent to Strawberry Creek. This alternative would be chosen along with an upgrade to the existing WTP or new WTP construction alternative.

Cumulative seepage flow rate, gpm = 10 gpm

Transfer flow rate, gpm = 30 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	**CAPITAL COSTS**					
1.1	CIVIL/SITEWORK					
1.1.1	Sumps	*5 total*				
1.1.1.1	Excavation	5	CY	52	1,000	Means Heavy Construction Cost Data (2001), 02240-500-0300
1.1.1.2	Backfill	4	CY	22	1,000	Means Heavy Construction Cost Data (2001), 02315-100-0300
1.1.2	Pond C Collection Ditch					
1.1.2.1	Excavation	500	CY	4.05	3,000	Means Heavy Construction Cost Data (2001), 02315-900-0050
1.1.2.2	Compaction	500	CY	2.71	2,000	Means Heavy Construction Cost Data (2001), 02315-900-1900
1.1.2.3	Trimming	8625	SF	0.42	4,000	Means Heavy Construction Cost Data (2001), 02315-900-2100
1.1.3	Piping (Trenching, Backfill, and Bedding)					
1.1.3.1	Sump Collectors	350	LF	3.57	2,000	Means Heavy Construction Cost Data (2001), 02315-940-0700, -1700, and -130-0200
1.1.3.2	Main Collector	900	LF	3.57	4,000	Means Heavy Construction Cost Data (2001), 02315-940-0700, -1700, and -130-0200
1.1.3.3	Transfer to Sunday Pit	3250	LF	2.05	7,000	Means Heavy Construction Cost Data (2001), 02315-940-3100 (adjusted by 20%) and -130-0200
				Subtotal	*24,000*	
1.2	STRUCTURAL					
1.2.1	Concrete Sump	5	EA	1,054	6,000	Means Heavy Construction Cost Data (2001), 02630-200-0800
1.2.1.1	HDPE Liner for Sump	250	SF	7.67	2,000	Means Heavy Construction Cost Data (2001), 02660-400-0200 and $60/hr at 5hrs per sump
1.2.2	HDPE Lining for Pond C Collection Ditch	10875	SF	1.05	12,000	Means Heavy Construction Cost Data (2001), 02630-400-0200
1.2.3	Concrete Foundation for Storage Tank	3	CY	161	1,000	Means Heavy Construction Cost Data (2001), 03300-130-4050
				Subtotal	*21,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Piping					
1.3.1.1	CPVC - 1" (Sump Discharge)	350	LF	2.45	1,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2100
1.3.1.2	CPVC - 2" (Main Collection Header)	900	LF	4.65	5,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2120
1.3.1.3	CPVC - 3" (Transfer to Sunday Pit)	3250	LF	9.10	30,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2160
1.3.1.4	Valves and Appurtenances	1	LS	21,000	21,000	Note 10
1.3.2	Storage Tank	1	LS	10,000	10,000	VQ
1.3.3	Submersible Pump	1	EA	4,500	5,000	VQ
				Subtotal	*72,000*	
1.4	ELECTRICAL	1	LS	29,000	*29,000*	Note 7
1.5	INSTRUMENTATION and CONTROLS	1	LS	15,000	*15,000*	Note 7
	Capital Costs			**Subtotal**	**161,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.6	CONSTRUCTION PRORATES	1	LS	96,000	*96,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	33,000		
	Contractor's Profit [b]		10% of Total Cost + GC	20,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	43,000		
1.7	ENGINEERING COSTS	1	LS	50,000	*50,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	21,000		
	Project Management		5% of Total Cost + Const Prorates	13,000		
	Construction Management		6% of Total Cost + Const Prorates	16,000		
	CAPITAL COST			**Total**	**307,000**	
2	**ANNUAL COSTS**					
2.1	ARD Transfer rom Hoodoo Gulch Seepage Storage Tank to Strawberry Pond (at 8 hrs/day)	5	HP	429/(HP*yr)	*800*	Note 6
	Annual O&M Costs			**Subtotal**	**800**	
2.2	CONSTRUCTION PRORATES	1	LS	600	*600*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	200		
	Contractor's Profit [b]		10% of Total Cost + GC	100		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	300		
2.3	ENGINEERING COSTS (Construction Management only)	1	LS	100	*100*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	100		
	ANNUAL O&M COST			**Total**	**1,500**	

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

D Alternative 4a - Follow Existing Chemical Precipitation with Membrane Filtration (300 gpm)

Upgrades to the existing WTP would be made to increase operational efficiency, and to meet ARAR requirements. The proposed process train would include the addition of microfiltration (MF) and nanofiltration (NF) membranes. The reject stream from the MF membrane would be blended with influent at the head of the plant; reject from the NF membrane would be routed to a mechanical evaporation unit. Sludge residuals (cake and salts) would be disposed of at an onsite location. This alternative would be selected along with either Alternative 3a or 3b.

Treatment Capacity, gpm = 300 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	264	CY	10	3,000	PW
1.1.2	Fine Grading	264	SY	1	300	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	88	CY	20	2,000	PW
1.1.4	Aggregate below SOG	88	CY	19	2,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	1,000	1,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*8,300*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	2000	SF	10	20,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building and Tank Foundation	88	CY	250	22,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*42,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Post Clarifier Acid Addition					
1.3.1.1	Storage Tank	1	EA	14,000	14,000	VQ
1.3.1.2	Metering Pump	1	EA	5,463	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.1.3	Rapid Mix Tank	1	EA	4,500	5,000	VQ
1.3.1.4	Mixer	1	EA	2,500	3,000	
1.3.2	Membrane System					
1.3.2.1	MF Membrane	1	LS	437,500	438,000	VQ
1.3.2.2	MF Membrane	1	LS	250,000	250,000	VQ
1.3.2.3	NF Membrane	1	LS	312,500	313,000	VQ
1.3.2.4	NF Membrane	1	LS	187,500	188,000	VQ
1.3.2.5	Membrane Reject Evaporator	12	EA	68,750	825,000	VQ
1.3.3	Sludge Conditioning/Handling Equipment					
1.3.3.1	Sludge Recycle Pump	1	EA	16,875	17,000	VQ
1.3.3.2	Sludge-to-Waste Pump	2	EA	16,875	34,000	VQ
1.3.3.3	Sludge Storage Tank	1	LS	21,500	22,000	VQ
1.3.3.4	Sludge Transfer Pump to Filter Press	1	EA	16,875	17,000	VQ
1.3.3.5	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.3.6	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.3.7	Filter Press	1	EA	175,000	175,000	VQ
1.3.3.8	Filtrate Return Pump	1	EA	16,875	17,000	VQ

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.4	Piping					
1.3.4.1	PVC - 1"	400	LF	9	4,000	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.4.2	PVC - 4"	225	LF	15	4,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.4.3	PVC - 6"	150	LF	21	4,000	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.4.4	PVC - 8"	25	LF	33	900	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.4.5	HDPE - 4"	300	LF	23	7,000	Note 11
1.3.4.6	HDPE - 8"	200	LF	32	7,000	Note 11
1.3.4.7	Gas Line, 4" diameter	26400	LF	11	291,000	Note 15
1.3.4.7.1	Rock Blasting and Burial	10560	LF	15	159,000	Note 15
1.3.4.8	Valves and Appurtenances	1	LS	16,200	17,000	Note 10
				Subtotal	*2,829,000*	
1.4	ELECTRICAL	1	LS	281,000	*281,000*	Note 7
1.5	INSTRUMENTATION and CONTROLS	1	LS	351,000	*351,000*	Note 7
	Capital Costs			**Subtotal**	**3,512,000**	
1.6	CONSTRUCTION PRORATES	1	LS	2,053,000	*2,053,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	703,000		
	Contractor's Profit [b]		10% of Total Cost + GC	422,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	928,000		
1.7	ENGINEERING COSTS	1	LS	1,059,000	*1,059,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	446,000		
	Project Management		5% of Total Cost + Const Prorates	279,000		
	Construction Management		6% of Total Cost + Const Prorates	334,000		
	CAPITAL COST			**Total**	**6,624,000**	
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Hydroxide (Caustic)	300	gpm	2,713	814,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.2	Polymer	300	gpm	174	53,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.3	Acid	300	gpm	17	6,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*873,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	*27,000*	
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	8	annual salary	38,100	305,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*642,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.5.2.5	Fuel	1	year	138,000	138,000	Use Means hourly operating costsfor each Item 2.5.2 at 8 hrs, 365 days
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.1.4	Sludge Recycle	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.5	Sludge-to-Waste	20	HP	429/(HP*yr)	9,000	Note 6
2.5.6.3.1.6	Sludge Storage to Filter Press	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.1.7	Filtrate Return Pump	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.2	Chemical Feed Systems					
2.5.6.3.2.1	Hydroxide Feed	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.2.2	Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.2.3	Sludge Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3	Mixers					
2.5.6.3.3.1	Sludge Mixing Tank	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.2	Rapid Mix	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.3.3	Flocculation	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.4	Sludge Storage Tank	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.3.5	Clarifier Scraper Drive	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.4	Membrane System					
2.5.6.3.4.1	MF Membrane	9	HP	429/(HP*yr)	4,000	Note 6
2.5.6.3.4.2	NF Membrane	120	HP	429/(HP*yr)	52,000	Note 6
2.5.6.3.5	Sludge Handling Equipment					
2.5.6.3.5.1	Filter Press	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.4	Gas					
2.5.6.4.1	Evaporators	60	gpm	10,512/(gpm*yr)	631,000	Note 14
2.5.6.5	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*1,446,000*	
	Annual O&M Costs			**Subtotal**	**3,051,000**	
2.6	CONSTRUCTION PRORATES	1	LS	1,784,000	*1,784,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	611,000		
	Contractor's Profit [b]		10% of Total Cost + GC	367,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	806,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	291,000	*291,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	291,000		
	ANNUAL O&M COST			**Total**	**5,126,000**	

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

E Alternative 5a - New ARD WTP with Caustic Addition, Chemical Precipitation, and Membrane Filtration (375 gpm)

Alternative 5a would include the construction of a new WTP located south of Strawberry Creek Pond. Alternative 3a or 3b would collect Hoodoo Gulch seep flows and pump them to either Sunday Pit or Strawberry Pond. The new WTP would include two separate treatment trains, each having treatment capacity for approximately half the influent flow. Total treatment capacity equals 375 gpm.

The train would consist of chemical precipitation and membrane filtration. Sodium hydroxide would be used to adjust pH to precipitate metal hydroxides. Resultant sludge would be processed using a filter press. MF membranes would be used as a pretreatment step prior to the NF membranes. The MF reject would be blended with influent wastewater at the headworks. The NF membrane would be used to reduce TDS concentrations and remove ions that are not precipitated during hydroxide addition. The NF reject would be processed using mechanical evaporation. Sludge residuals (cake and salts) would be disposed of at an onsite location.

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	256	CY	10	3,000	PW
1.1.2	Fine Grading	384	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	128	CY	20	3,000	PW
1.1.4	Aggregate below SOG	128	CY	19	3,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	1,000	1,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*11,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	3000	SF	10	30,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	128	CY	250	32,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Clarifier/Sludge Storage Tank Foundations	58	CY	250	15,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*77,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ
1.3.2	Sludge Recycle Mixing Tank	1	LS	4,375	5,000	VQ
1.3.2.1	Mixer	1	EA	10,000	10,000	
1.3.2.2	Chemical Dry Feeder/Hopper - NaHCO3 add'n	1	EA	6,250	7,000	VQ
1.3.3	Hydroxide Storage Unit	1	LS	21,500	22,000	VQ
1.3.3.1	Metering Pump	1	EA	5,463	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.4	Rapid Mix Tank	1	LS	8,750	9,000	VQ
1.3.4.1	Mixer	2	EA	2,500	5,000	
1.3.5	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.5.1	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.6	Flocculation Tank	1	LS	28,000	28,000	VQ
1.3.6.1	Mixer	1	EA	20,000	20,000	
1.3.7	Circular Clarifier	1	EA	204,000	204,000	VQ
1.3.7.1	Sludge Recycle Pump	1	EA	16,875	17,000	VQ
1.3.7.2	Sludge-to-Waste Pump	2	EA	16,875	34,000	VQ

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.8	Post Clarifier Acid Addition					
1.3.8.1	Storage Tank	1	EA	14,000	14,000	VQ
1.3.8.2	Metering Pump	1	EA	5,463	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.8.3	Rapid Mix Tank	1	EA	4,500	5,000	VQ
1.3.8.4	Mixer	1	EA	2,500	3,000	
1.3.9	Membrane System					
1.3.9.1	MF Membrane	2	EA	437,500	875,000	VQ
1.3.9.2	NF Membrane	4	EA	187,500	750,000	VQ
1.3.9.3	Membrane Reject Evaporator	15	EA	68,750	1,032,000	VQ
1.3.10	Settled Water Storage Tank	1	EA	17,500	18,000	VQ
1.3.11	Sludge Conditioning/Handling Equipment					
1.3.11.1	Sludge Storage Tank	1	EA	21,500	22,000	VQ
1.3.11.2	Sludge Transfer Pump to Filter Press	2	EA	16,875	34,000	VQ
1.3.11.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.11.4	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.11.5	Filter Press	1	EA	175,000	175,000	VQ
1.3.11.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ
1.3.12	Piping					
1.3.12.1	PVC - 1"	500	LF	9	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.12.2	PVC - 2"	0	LF	0	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.12.3	PVC - 4"	285	LF	15	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.12.4	PVC - 6"	620	LF	21	13,000	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.5	PVC - 8"	245	LF	33	9,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.12.6	PVC - 12"	0	LF	0	0	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.7	HDPE - 2"	0	LF	0	0	Note 11
1.3.12.8	HDPE - 4"	250	LF	23	6,000	Note 11
1.3.12.9	HDPE - 8"	600	LF	32	20,000	Note 11
1.3.12.10	Gas Line, 4" diameter	26400	LF	11	291,000	Note 15
1.3.12.10.1	Rock Blasting and Burial	10560	LF	15	159,000	Note 15
1.3.12.11	Valves and Appurtenances	1	LS	34,800	35,000	Note 10
				Subtotal	*3,927,000*	
1.4	ELECTRICAL	1	LS	407,000	*407,000*	Note 7
1.5	INSTRUMENTATION and CONTROLS	1	LS	508,000	*508,000*	Note 7
	Capital Costs			**Subtotal**	**4,930,000**	
1.6	CONSTRUCTION PRORATES	1	LS	2,880,000	*2,880,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	986,000		
	Contractor's Profit [b]		10% of Total Cost + GC	592,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	1,302,000		
1.7	ENGINEERING COSTS	1	LS	1,485,000	*1,485,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	625,000		
	Project Management		5% of Total Cost + Const Prorates	391,000		
	Construction Management		6% of Total Cost + Const Prorates	469,000		
	CAPITAL COST			**Total**	**9,295,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Sodium Hydroxide	375	gpm	2713	1,018,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.2	Polymer	375	gpm	174	66,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.3	Bicarbonate	375	gpm	129	49,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.4	Acid	375	gpm	17	7,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*1,140,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	*27,000*	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	8	annual salary	38,100	305,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*642,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.1.4	Sludge Recycle	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.1.5	Sludge-to-Waste	20	HP	429/(HP*yr)	9,000	Note 6
2.5.6.3.1.6	Sludge Storage to Filter Press	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.1.7	Filtrate Return Pump	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.2	Chemical Feed Systems					
2.5.6.3.2.1	Hydroxide Feed	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.2.2	Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.2.3	Sludge Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.5.6.3.3	Mixers					
2.5.6.3.3.1	Sludge Mixing Tank	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.2	Rapid Mix	15	HP	429/(HP*yr)	7,000	Note 6
2.5.6.3.3.3	Flocculation	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.3.4	Sludge Storage Tank	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.3.5	Clarifier Scraper Drive	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.4	Membrane System					
2.5.6.3.4.1	MF Membrane	11	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.4.2	NF Membrane	150	HP	429/(HP*yr)	65,000	Note 6
2.5.6.3.5	Sludge Handling Equipment					
2.5.6.3.5.1	Filter Press	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.4	Gas					
2.5.6.4.1	Evaporators	75	gpm	10,512/(gpm*yr)	789,000	Note 14
2.5.6.5	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*1,616,000*	
	Annual O&M Costs			**Subtotal**	**3,488,000**	
2.6	CONSTRUCTION PRORATES	1	LS	2,038,000	*2,038,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	698,000		
	Contractor's Profit [b]		10% of Total Cost + GC	419,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	921,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	332,000	*332,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	332,000		
	ANNUAL O&M COST			**Total**	**5,858,000**	

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

F Alternative 5b - New ARD WTP with Lime Addition, Chemical Precipitation, and Membrane Filtration (375 gpm)

Alternative 5b would include the construction of a new WTP located south of Strawberry Creek Pond. Either Alternative 3a or 3b would be selected along with this alternative. The new WTP would include two separate treatment trains, each having treatment capacity for approximately half the influent flow. Total treatment capacity equals 375 gpm.

The train would consist of chemical precipitation and membrane filtration. Lime would be used to adjust pH to precipitate metal hydroxides. Resultant sludge would be processed using a filter press. MF membranes would be used as a pretreatment step prior to the NF membranes. The MF reject would be blended with influent wastewater at the headworks. The NF membrane would be used to reduce TDS concentrations and remove ions that are not precipitated during hydroxide addition. The NF reject would be processed using mechanical evaporation. Sludge residuals (cake and salts) would be disposed of at an onsite location.

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	256	CY	10	3,000	PW
1.1.2	Fine Grading	384	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	128	CY	20	3,000	PW
1.1.4	Aggregate below SOG	128	CY	19	3,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	1,000	1,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*11,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	3000	SF	10	30,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	128	CY	250	32,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Clarifier/Sludge Storage Tank Foundations	75	CY	250	19,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*81,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ
1.3.2	Sludge Recycle Mixing Tank	1	LS	4,375	5,000	VQ
1.3.2.1	Mixer	1	EA	10,000	10,000	VQ
1.3.2.2	Chemical Dry Feeder/Hopper - NaHCO3 add'n	1	EA	6,250	7,000	VQ
1.3.3	Lime Slaker	1	EA	260,000	260,000	VQ
1.3.4	Rapid Mix Tank	1	LS	8,750	9,000	VQ
1.3.4.1	Mixer	2	EA	2,500	5,000	VQ
1.3.5	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.5.1	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.6	Flocculation Tank	1	LS	28,000	28,000	VQ
1.3.6.1	Mixer	2	EA	10,000	20,000	VQ
1.3.7	Circular Clarifier	1	EA	204,000	204,000	VQ
1.3.7.1	Sludge Recycle Pump	1	EA	16,875	17,000	VQ
1.3.7.2	Sludge-to-Waste Pump	2	EA	16,875	34,000	VQ
1.3.8	Post Clarifier Acid Addition					
1.3.8.1	Storage Tank	1	EA	11,200	12,000	VQ
1.3.8.2	Metering Pump	1	EA	4,370	5,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.8.3	Rapid Mix Tank	1	EA	3,600	4,000	VQ
1.3.8.4	Mixer	1	EA	2,000	2,000	VQ

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.9	Membrane System					
1.3.9.1	MF Membrane	1	LS	437,500	438,000	VQ
1.3.9.2	NF Membrane	1	LS	375,000	375,000	VQ
1.3.9.3	Membrane Reject Evaporator	15	EA	68,750	1,032,000	VQ
1.3.10	Settled Water Storage Tank	1	EA	17,500	18,000	VQ
1.3.11	Sludge Conditioning/Handling Equipment					
1.3.11.1	Sludge Storage Tank	1	EA	21,500	22,000	VQ
1.3.11.2	Sludge Transfer Pump to Filter Press	2	EA	16,875	34,000	VQ
1.3.11.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.11.4	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.11.5	Filter Press	1	EA	175,000	175,000	VQ
1.3.11.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ
1.3.12	Piping					
1.3.12.1	PVC - 1"	500	LF	9	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.12.2	PVC - 2"	0	LF	0	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.12.3	PVC - 4"	285	LF	15	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.12.4	PVC - 6"	620	LF	21	13,000	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.5	PVC - 8"	245	LF	33	9,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.12.6	PVC - 12"	0	LF	0	0	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.7	HDPE - 2"	0	LF	0	0	Note 11
1.3.12.8	HDPE - 4"	250	LF	23	6,000	Note 11
1.3.12.9	HDPE - 8"	600	LF	32	20,000	Note 11
1.3.12.10	Gas Line, 4" diameter	26400	LF	11	291,000	Note 15
1.3.12.10.1	Rock Blasting and Burial	10560	LF	15	159,000	Note 15
1.3.12.11	Valves and Appurtenances	1	LS	34,800	35,000	Note 10
				Subtotal	*3,342,000*	
1.4	ELECTRICAL	1	LS	334,000	*334,000*	Note 7
1.5	INSTRUMENTATION and CONTROLS	1	LS	418,000	*418,000*	Note 7
	Capital Costs			**Subtotal**	**4,186,000**	
1.6	CONSTRUCTION PRORATES	1	LS	2,447,000	*2,447,000*	Note 12
	General Conditions (Overhead)[a]	20% of Total Cost		838,000		
	Contractor's Profit[b]	10% of Total Cost + GC		503,000		
	Scope and Bid Design Contingency[c]	20% of Total Cost + GC + Profit		1,106,000		
1.7	ENGINEERING COSTS	1	LS	1,261,000	*1,261,000*	Note 13
	Remedial Design	8% of Total Cost + Const Prorates		531,000		
	Project Management	5% of Total Cost + Const Prorates		332,000		
	Construction Management	6% of Total Cost + Const Prorates		398,000		
	CAPITAL COST			**Total**	**7,894,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Lime	375	gpm	541	203,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.2	Polymer	375	gpm	174	66,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.3	Bicarbonate	375	gpm	129	49,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.4	Acid	375	gpm	14	6,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*324,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	*27,000*	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	9	annual salary	38,100	343,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*680,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.1.4	Sludge Recycle	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.1.5	Sludge-to-Waste	20	HP	429/(HP*yr)	9,000	Note 6
2.5.6.3.1.6	Sludge Storage to Filter Press	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.1.7	Filtrate Return Pump	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.2	Chemical Feed Systems					
2.5.6.3.2.1	Hydroxide Feed	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.2.2	Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.2.3	Sludge Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.5.6.3.3	Mixers					
2.5.6.3.3.1	Sludge Mixing Tank	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.2	Rapid Mix	15	HP	429/(HP*yr)	7,000	Note 6
2.5.6.3.3.3	Flocculation	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.4	Sludge Storage Tank	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.3.5	Clarifier Scraper Drive	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.4	Membrane System					
2.5.6.3.4.1	MF Membrane	6	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.4.2	NF Membrane	75	HP	429/(HP*yr)	33,000	Note 6
2.5.6.3.5	Sludge Handling Equipment					
2.5.6.3.5.1	Filter Press	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.4	Gas					
2.5.6.4.1	Evaporators	37.5	gpm	10,512/(gpm*yr)	395,000	Note 14
2.5.6.5	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*1,189,000*	
	Annual O&M Costs			**Subtotal**	**2,283,000**	
2.6	CONSTRUCTION PRORATES	1	LS	1,334,000	*1,334,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	457,000		
	Contractor's Profit[b]		10% of Total Cost + GC	274,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	603,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	218,000	*218,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	218,000		
	ANNUAL O&M COST			**Total**	**3,835,000**	

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

G Alternative 5f - New ARD WTP Including Anaerobic Sulfate Reduction, Metal Sulfide/Carbonate Precipitation and Partial Stream Membrane Filtration (375 gpm)

Alternative 5a would include the construction of a new WTP located south of Strawberry Creek Pond. Either Alternative 3a or 3b would be selected along with this alternative. The new WTP would include two separate treatment trains, each having treatment capacity for approximately half the influent flow. Total treatment capacity equals 375 gpm.

Alternative 5e includes an anaerobic unit process that would use sulfate-reducing bacteria to produce sulfide and bicarbonate. Reactions between the sulfide, bicarbonate and metals in solution would precipitate metal sulfide and carbonate complexes. Metals precipitation and off-gassing of carbon dioxide and hydrogen sulfide would reduce TDS concentrations. After the anaerobic process, a flocculant would be added for gravity clarification. The resultant sludge from the clarifier would be processed by a filter press. A portion (approximately 20 percent) of the clarifier effluent would be routed through MF and RO membranes to further reduce TDS and ensure compliance with ARARs. The RO reject would be processed using mechanical evaporation. Sludge residuals (cake and salts) would be disposed of at

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	351	CY	10	4,000	PW
1.1.2	Fine Grading	527	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	176	CY	20	4,000	PW
1.1.4	Aggregate below SOG	176	CY	19	4,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	1,000	1,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*14,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	4210	SF	10	43,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	176	CY	250	44,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Clarifier/Sludge Storage Tank Foundations	58	CY	250	15,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*102,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ
1.3.2	Rapid Mix Tank	1	LS	14,000	14,000	VQ
1.3.2.1	Mixer	1	LS	12,500	13,000	VQ
1.3.3	Chemical Addition Storage Tank (Acetic Acid)	1	LS	21,500	22,000	VQ
1.3.3.1	Metering Pump	1	LS	5,463	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.3.2	Chemical Dry Feeder/Hopper - $NaHCO_3$ add'n	1	EA	6,250	7,000	VQ
1.3.4	Fluidized Bed Reactor	8	EA	125,000	1,000,000	12,000 gallon; 316SS Pressure Tanks, 10' diam, 20' h (Eric Maer, Muehler Co.)
1.3.4.1	Bed Media	175,500	lbs	1.25	220,000	Calgon GAC (6500 ft^3 @ 27 lbs/ft^3)
1.3.4.2	Transfer Pumps	8	EA	31,250	250,000	15 hp ea
1.3.4.3	PD Blower	1	EA	28,125	29,000	Quote from equipment manufacturer
1.3.4.4	Heaters	8	EA	6,250	50,000	VQ
1.3.4.5	Heat Exchanger	1	EA	8,750	9,000	VQ
1.3.4.5.1	Transfer Pump	2	EA	16,875	34,000	VQ
1.3.5	Polymer Storage Tank	1	LS	4,375	5,000	VQ
1.3.5.1	Polymer Activation/Feed System	1	LS	6,250	7,000	VQ

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.6	Flocculation Tank	2	EA	14,000	28,000	VQ
1.3.6.1	Mixer	2	EA	12,500	25,000	VQ
1.3.7	Circular Clarifier	1	EA	204,000	204,000	VQ
1.3.7.1	Sludge-to-Waste Pump	2	LS	16,875	34,000	VQ
1.3.8	Post Clarifier Acid Addition					
1.3.8.1	Storage Tank	1	EA	14,000	14,000	VQ
1.3.8.2	Metering Pump	1	EA	5,463	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.8.3	Rapid Mix Tank	1	EA	4,500	5,000	VQ
1.3.8.4	Mixer	1	EA	2,500	3,000	VQ
1.3.9	Membrane System					
1.3.9.1	MF Membrane	1	LS	250,000	250,000	VQ
1.3.9.2	NF Membrane	1	LS	187,500	188,000	VQ
1.3.9.3	Membrane Reject Evaporator	3	EA	68,750	207,000	VQ
1.3.10	Settled Water Storage Tank	1	EA	17,500	18,000	VQ
1.3.11	Sludge Conditioning/Handling Equipment					
1.3.11.1	Sludge Storage Tank	1	EA	21,500	22,000	VQ
1.3.11.2	Sludge Transfer Pump to Filter Press	2	EA	16,875	34,000	VQ
1.3.11.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.11.4	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.11.5	Filter Press	1	EA	175,000	175,000	VQ
1.3.11.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ
1.3.12	Piping					
1.3.12.1	PVC - 1"	180	LF	9	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.12.2	PVC - 2"	150	LF	11	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.12.3	PVC - 4"	630	LF	15	10,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.12.4	PVC - 6"	190	LF	21	4,000	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.5	PVC - 8"	130	LF	33	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.12.6	PVC - 12"	640	LF	66	43,000	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.7	HDPE - 2"	100	LF	15	2,000	Note 11
1.3.12.8	HDPE - 4"	0	LF	23	0	Note 11
1.3.12.9	HDPE - 8"	600	LF	32	20,000	Note 11
1.3.12.10	Gas Line, 4" diameter	26400	LF	11	291,000	Note 15
1.3.12.10.1	Rock Blasting and Burial	10560	LF	15	159,000	Note 15
1.3.12.11	Valves and Appurtenances	1	LS	52,800	53,000	Note 10
				Subtotal	*3,542,000*	
1.4	ELECTRICAL	1	LS	352,100	*352,100*	Note 7
1.5	INSTRUMENTATION and CONTROLS	1	LS	440,100	*440,100*	Note 7
	Capital Costs			**Subtotal**	**4,349,000**	
1.6	CONSTRUCTION PRORATES	1	LS	2,541,000	*2,541,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	870,000		
	Contractor's Profit [b]		10% of Total Cost + GC	522,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	1,149,000		
1.7	ENGINEERING COSTS	1	LS	1,311,000	*1,311,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	552,000		
	Project Management		5% of Total Cost + Const Prorates	345,000		
	Construction Management		6% of Total Cost + Const Prorates	414,000		
	CAPITAL COST			**Total**	**8,302,200**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Bicarbonate	375	gpm	129	49,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.2	Polymer	375	gpm	174	66,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.3	Acetic Acid	375	gpm	1473	553,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.4	pH Adjustment (Acid)	375	gpm	55	21,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*689,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	*27,000*	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	8	annual salary	38,100	305,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*642,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.1.4	Heat Exchanger Transfer	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.5	Sludge-to-Waste	20	HP	429/(HP*yr)	9,000	Note 6
2.5.6.3.1.6	Sludge Storage to Filter Press	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.7	Filtrate Return Pump	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.2	Chemical Feed Systems					
2.5.6.3.2.1	Chemical Feed	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.2.2	Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.2.3	Sludge Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.5.6.3.3	Mixers					
2.5.6.3.3.1	Sludge Mixing Tank	0	HP	429/(HP*yr)	0	Note 6
2.5.6.3.3.2	Rapid Mix	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.3.3	Flocculation	0	HP	429/(HP*yr)	0	Note 6
2.5.6.3.3.4	Sludge Storage Tank	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.3.5	Clarifier Scraper Drive	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.4	Membrane System					
2.5.6.3.4.1	MF Membrane	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.4.2	NF Membrane	30	HP	429/(HP*yr)	13,000	Note 6
2.5.6.3.4.3	Heaters	350	kW	574/(kW*yr)	201,000	Note 6
2.5.6.3.5	Sludge Handling Equipment					
2.5.6.3.5.1	Filter Press	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.4	Gas					
2.5.6.4.1	Evaporators	11	gpm	10,512/(gpm*yr)	119,000	Note 14
2.5.6.5	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*1,088,000*	
	Annual O&M Costs			**Subtotal**	**2,509,000**	
2.6	CONSTRUCTION PRORATES	1	LS	1,467,000	*1,467,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	502,000		
	Contractor's Profit [b]		10% of Total Cost + GC	302,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	663,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	239,000	*239,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	239,000		
	ANNUAL O&M COST			**Total**	**4,215,000**	

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

H **Alternative 5g - New ARD WTP with Proprietary Microencapsulation/Precipitation and Partial Stream Membrane Filtration (375 gpm)**

Alternative 5g would include the construction of a new WTP located south of Strawberry Creek Pond. Either Alternative 3a or 3b would be selected along with this alternative. The new WTP would include a redundant process train, with a total treatment capacity equal to 375 gpm.

The treatment process would utilize a proprietary chemical silica reagent to encapsulate metal hydroxides. The formed particulate would be settled out within sedimentatin basins. Partial stream membrane filtration would be used to meet ARAR requirements. The process train includes the chemical feed system; mix tanks; sedimentation basins; sludge tanks; and all pumps, instrumentation and appurtenances. Also included are annual O&M operations for the treatment plant including utilities, staff, administration, site snow removal, and weekly monitoring sampling and support. Residual sludge solids would be disposed at an onsite location.

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	784	CY	10	8,000	PW
1.1.2	Fine Grading	790	SY	1	800	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	261	CY	20	6,000	PW
1.1.4	Aggregate below SOG	261	CY	19	6,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	2,000	2,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*22,800*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	6400	SF	9	58,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	261	CY	250	66,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Sludge Storage Tank Foundation	17	CY	250	5,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*129,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ
1.3.2	MicroEncapsulation Process Train, including:	1	LS	750,000	750,000	VQ
	metering equipment					
	chemical storage					
	chemical feed					
	sludge pumps/storage tanks/handling					
	piping					
	instrumentation & controls					
1.3.3	Membrane System					
1.3.3.1	MF Membrane	1	LS	250,000	250,000	VQ
1.3.3.2	NF Membrane	1	LS	187,500	188,000	VQ
1.3.3.3	Membrane Reject Evaporator	3	EA	68,750	207,000	VQ
1.3.4	Settled Water Storage Tank	1	LS	10,000	10,000	VQ
1.3.5	Piping					
1.3.5.1	PVC - 1"	0	LF	9	0	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.5.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.5.3	PVC - 4"	100	LF	15	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.5.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.5	PVC - 8"	40	LF	33	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.5.6	PVC - 12"	0	LF	66	0	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.7	HDPE - 2"	0	LF	15	0	Note 11
1.3.5.8	HDPE - 4"	0	LF	23	0	Note 11

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.5.9	HDPE - 8"	600	LF	32	20,000	Note 11
1.3.5.10	Gas Line, 4" diameter	26400	LF	11	291,000	Note 15
1.3.5.10.1	Rock Blasting and Burial	10560	LF	15	159,000	Note 15
1.3.5.11	Valves and Appurtenances	1	LS	14,400	15,000	Note 10
				Subtotal	*1,938,000*	
1.5	ELECTRICAL	1	LS	84,000	84,000	Note 7
1.6	INSTRUMENTATION and CONTROLS	1	LS	105,000	105,000	Note 7
	Capital Costs			**Subtotal**	**2,279,000**	
1.6	CONSTRUCTION PRORATES	1	LS	1,332,000	*1,332,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	456,000		
	Contractor's Profit[b]		10% of Total Cost + GC	274,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	602,000		
1.7	ENGINEERING COSTS	1	LS	687,000	*687,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	289,000		
	Project Management		5% of Total Cost + Const Prorates	181,000		
	Construction Management		6% of Total Cost + Const Prorates	217,000		
	CAPITAL COST			**Total**	**4,146,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Chemicals (inc. proprietary)	375 gpm	gpm	2150	807,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*807,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	27,000	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	8	annual salary	38,100	305,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*642,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.2	Process Train	15	HP	429/(HP*yr)	7,000	Note 6
2.5.6.3.3	MF Membrane	11	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.4	NF Membrane	150	HP	429/(HP*yr)	65,000	Note 6
2.5.6.4	Gas					
2.5.6.4.1	Evaporators	75	gpm	10,512/(gpm*yr)	789,000	Note 14
2.5.6.5	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*1,585,000*	
	Annual O&M Costs			**Subtotal**	**3,124,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.6	CONSTRUCTION PRORATES	1	LS	1,825,000	*1,825,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	625,000		
	Contractor's Profit[b]		10% of Total Cost + GC	375,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	825,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	297,000	*297,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	297,000		
	ANNUAL O&M COST			**Total**	**5,246,000**	

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

I Alternative 5h - New ARD WTP with Optimized Chemical Precipitation Using Proprietary Metals Coordination Process, and Partial Stream Membrane Filtration (375 gpm)

Includes the construction of a newWTP located south of Strawberry Pond. Either Alternative 3a or 3b would be selected along with this alternative. Total treatment capacity equals 375 gpm.

The treatment process would utilize an optimized precipitation treatment process using proprietary polymer technology to encapsulate metal hydroxides. Chemical reagents would be used to adjust pH during the process prior to addition of polymers. Sedimentation followed by microfiltration membranes would be used to remove the formed metal-containing particulates. Residual sludge solids would be disposed at an onsite location.The process train also includes the chemical and polymer feed systems; mix tanks; sedimentation tanks; sludge tanks; and all pumps, instrumentation and appurtenances. Also included are annual O&M operations for the treatment plant including utilities, staff, administration, site snow removal, and weekly monitoring sampling and support.

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	784	CY	10	8,000	PW
1.1.2	Fine Grading	790	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	261	CY	20	6,000	PW
1.1.4	Aggregate below SOG	261	CY	19	6,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	2,000	2,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*23,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	6400	SF	9	58,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	261	CY	250	66,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Sludge Storage Tank Foundation	17	CY	250	5,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*129,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ
1.3.2	Optimized Process Train, including:	1	LS	1,462,750	1,463,000	VQ - Note 16
	pumps					
	chemical storage					
	chemical feed					
	MF membranes					
	piping					
	accessories					
	Electrical and I&C					
1.3.3	Membrane System					
1.3.3.2	NF Membrane	2	EA	187,500	375,000	VQ
1.3.3	Settled Water Storage Tank	1	LS	10,000	10,000	VQ
1.3.4	Sludge Conditioning/Handling Equipment					
1.3.4.1	Sludge Storage Tank	1	LS	122,500	123,000	VQ
1.3.4.2	Sludge Transfer Pump to Filter Press	2	EA	16,875	34,000	VQ
1.3.11.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.11.4	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.4.3	Filter Press	1	EA	175,000	175,000	VQ
1.3.11.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.5	Piping					
1.3.5.1	PVC - 1"	0	LF	9	0	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.5.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.5.3	PVC - 4"	100	LF	15	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.5.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.5	PVC - 8"	40	LF	33	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.5.6	PVC - 12"	0	LF	66	0	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.7	HDPE - 2"	0	LF	15	0	Note 11
1.3.5.8	HDPE - 4"	0	LF	23	0	Note 11
1.3.5.9	HDPE - 8"	600	LF	32	20,000	Note 11
1.3.5.10	Valves and Appurtenances	1	LS	14,400	15,000	Note 10
				Subtotal	*2,291,000*	
1.5	ELECTRICAL	1	LS	50,000	*50,000*	Note 7
1.6	INSTRUMENTATION and CONTROLS	1	LS	63,000	*63,000*	Note 7
	Capital Costs			**Subtotal**	**2,556,000**	
1.7	CONSTRUCTION PRORATES	1	LS	1,494,000	*1,494,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	512,000		
	Contractor's Profit [b]		10% of Total Cost + GC	307,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	675,000		
1.8	ENGINEERING COSTS	1	LS	770,000	*770,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	324,000		
	Project Management		5% of Total Cost + Const Prorates	203,000		
	Construction Management		6% of Total Cost + Const Prorates	243,000		
	CAPITAL COST			**Total**	**4,668,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Hydroxide	1	LS	65,000	65,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.2	Chemicals (inc. proprietary)	1	LS	75,000	75,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*140,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	27,000	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	8	annual salary	38,100	305,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*642,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.2	Optimized Process Train	132.5	HP	429/(HP*yr)	57,000	Note 6
2.5.6.3.3	NF Membrane	150	HP	429/(HP*yr)	65,000	General Note 6
2.5.6.3.3	Sludge Handling Equipment					
2.5.6.3.3.1	Filter Press	6	HP	429/(HP*yr)	3,000	Note 6
2.5.6.4	Gas					
2.5.6.4.1	Evaporators	75	gpm	10,512/(gpm*yr)	789,000	General Note 14
2.5.6.5	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*1,633,000*	
	Annual O&M Costs			**Subtotal**	**2,505,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.6	CONSTRUCTION PRORATES	1	LS	1,464,000	*1,464,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	501,000		
	Contractor's Profit [b]		10% of Total Cost + GC	301,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	662,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	239,000	*239,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	239,000		
	ANNUAL O&M COST			**Total**	**4,208,000**	

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

J Alternative 6a - Upgrade Existing Caustic Chemical Precipitation ARD WTP With Additional Treatment Train and Filtration (ARAR waiver) (375 gpm)

Includes the upgrade of the existing WTP. Either Alternative 3a or 3b would be selected along with this alternative. The upgraded WTP would include two separate treatment trains, the new treatment train capacity would be approximately one quarter of the influent flow. Total treatment capacity equals 375 gpm.

The train would consist of chemical precipitation. Sodium hydroxide would be used to adjust pH to precipitate metal hydroxides. Resultant sludge would be processed using a filter press. Sludge residuals would be disposed of at an onsite location.

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	278	CY	10	3,000	PW
1.1.2	Fine Grading	278	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	93	CY	20	2,000	PW
1.1.4	Aggregate below SOG	93	CY	19	2,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	1,000	1,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*9,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	2500	SF	10	25,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	93	CY	250	24,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Clarifier/Sludge Storage Tank Foundations	58	CY	250	15,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*64,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	0	EA	40,000	0	VQ
1.3.2	Sludge Mixing Tank	1	LS	4,500	5,000	VQ
1.3.2.1	Mixer	1	LS	8,750	9,000	VQ
1.3.3	Hydroxide Storage Unit	1	LS	21,500	22,000	VQ
1.3.3.1	Metering Pump	1	LS	5,463	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.4	Rapid Mix Tank	1	LS	4,500	5,000	VQ
1.3.4.1	Mixer	1	LS	2,250	3,000	VQ
1.3.5	Polymer Storage Tank	1	LS	3,750	4,000	VQ
1.3.5.1	Polymer Activation/Feed System	1	LS	6,500	7,000	VQ
1.3.6	Flocculation Tank	1	LS	10,000	10,000	VQ
1.3.6.1	Mixer	1	LS	11,250	12,000	VQ
1.3.7	Circular Clarifier	1	EA	219,000	219,000	VQ
1.3.7.1	Sludge Recycle Pump	1	LS	16,875	17,000	VQ
1.3.7.2	Sludge-to-Waste Pump	1	LS	16,875	17,000	VQ
1.3.8	Post Clarifier Acid Addition					
1.3.8.1	Storage Tank	1	EA	11,200	12,000	VQ
1.3.8.2	Metering Pump	1	EA	4,370	5,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.8.3	Rapid Mix Tank	1	EA	3,600	4,000	VQ
1.3.8.4	Mixer	1	EA	2,000	2,000	VQ
1.3.9	Disc Filter	1	LS	108,750	109,000	VQ
1.3.10	Settled Water Storage Tank	1	LS	10,000	10,000	VQ
1.3.11	Sludge Conditioning/Handling Equipment					

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.11.1	Sludge Storage Tank	1	LS	14,000	14,000	VQ
1.3.11.2	Sludge Transfer Pump to Filter Press	2	EA	16,875	34,000	VQ
1.3.11.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.11.4	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.11.5	Filter Press	1	EA	175,000	175,000	VQ
1.3.11.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ
1.3.12	Piping					
1.3.12.1	PVC - 1"	80	LF	9	1,000	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.12.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.12.3	PVC - 4"	300	LF	15	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.12.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.5	PVC - 8"	0	LF	33	0	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.12.6	PVC - 12"	0	LF	66	0	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.7	HDPE - 2"	0	LF	15	0	Note 11
1.3.12.8	HDPE - 4"	200	LF	23	5,000	Note 11
1.3.12.9	HDPE - 8"	0	LF	32	0	Note 11
1.3.12.10	Valves and Appurtenances	1	LS	6,600	7,000	Note 10
				Subtotal	*747,000*	
1.4	ELECTRICAL	1	LS	85,500	*85,500*	Note 7
1.5	INSTRUMENTATION and CONTROLS	1	LS	106,800	*106,800*	Note 7
	Capital Costs			**Subtotal**	**955,000**	
1.6	CONSTRUCTION PRORATES	1	LS	559,000	*559,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	191,000		
	Contractor's Profit [b]		10% of Total Cost + GC	115,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	253,000		
1.7	ENGINEERING COSTS	1	LS	289,000	*289,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	122,000		
	Project Management		5% of Total Cost + Const Prorates	76,000		
	Construction Management		6% of Total Cost + Const Prorates	91,000		
	CAPITAL COST			Total	1,860,300	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Hydroxide (Caustic)	375 gpm	gpm	2713	1,018,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.2	Polymer	375 gpm	gpm	174	66,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.3	Acid	375 gpm	gpm	17	7,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*1,091,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	*27,000*	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	8	annual salary	38,100	305,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*642,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.1.4	Sludge Recycle	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.5	Sludge-to-Waste	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.6	Sludge Storage to Filter Press	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.7	Filtrate Return Pump	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.2	Chemical Feed Systems					
2.5.6.3.2.1	Hydroxide Feed	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.2.2	Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.2.3	Sludge Polymer Activation/Feed System	2.5	HP	429/(HP*yr)	2,000	Note 6

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.5.6.3.3	Mixers					
2.5.6.3.3.1	Sludge Mixing Tank	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.2	Rapid Mix	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.3.3	Flocculation	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.4	Sludge Storage Tank	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.3.5	Clarifier Scraper Drive	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.4	Sludge Handling Equipment					
2.5.6.3.4.1	Filter Press	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.5	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*761,000*	
	Annual O&M Costs			**Subtotal**	**2,584,000**	
2.6	CONSTRUCTION PRORATES	1	LS	1,511,000	*1,511,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	517,000		
	Contractor's Profit [b]		10% of Total Cost + GC	311,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	683,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	246,000	*246,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	246,000		
	ANNUAL O&M COST			**Total**	**4,341,000**	

Project: *Gilt Edge Mine* Updated: *7-Jun-01*
Project #: *4000-30291* Estimator: *BCD/KO*
Location: *Lawrence County, South Dakota* Project Status: *Final FFS (-30% to +50%)*

K Alternative 6b - Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Precipitation and upgrade With Additional Treatment Train and Filtration (ARAR waiver) (375 gpm)

Includes the upgrade of the existing WTP. Either Alternative 3a or 3b would be selected along with this alternative. The upgraded WTP would include two separate treatment trains, the new treatment train capacity would be approximately one quarter of the influent flow. Total treatment capacity equals 375 gpm.

The train would consist of chemical precipitation. Lime would be used to adjust pH to precipitate metal hydroxides. Resultant sludge would be processed using a filter press. Sludge residuals would be disposed of at an onsite location.

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	278	CY	10	3,000	PW
1.1.2	Fine Grading	278	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	93	CY	20	2,000	PW
1.1.4	Aggregate below SOG	93	CY	19	2,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	1,000	1,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*9,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	2500	SF	10	25,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	93	CY	250	24,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Clarifier/Sludge Storage Tank Foundations	75	CY	250	19,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*68,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	0	EA	40,000	0	VQ
1.3.2	Sludge Mixing Tank	1	LS	4,500	5,000	VQ
1.3.2.1	Mixer	1	LS	8,750	9,000	VQ
1.3.3	Hydroxide Feed Unit	0				
1.3.3.1	Metering Pump	1	LS	5,463	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.3.2	Slaker	1	LS	312,500	313,000	VQ
1.3.4	Rapid Mix Tank	1	LS	4,500	5,000	VQ
1.3.4.1	Mixer	1	LS	2,250	3,000	VQ
1.3.5	Polymer Storage Tank	1	LS	3,750	4,000	VQ
1.3.5.1	Polymer Activation/Feed System	1	LS	6,500	7,000	VQ
1.3.6	Flocculation Tank	1	LS	10,000	10,000	VQ
1.3.6.1	Mixer	1	LS	11,250	12,000	VQ
1.3.7	Circular Clarifier	1	EA	219,000	219,000	VQ
1.3.7.1	Sludge Recycle Pump	1	LS	16,875	17,000	VQ
1.3.7.2	Sludge-to-Waste Pump	1	LS	16,875	17,000	VQ
1.3.8	Post Clarifier Acid Addition					
1.3.8.1	Storage Tank	1	EA	14,000	14,000	VQ
1.3.8.2	Metering Pump	1	EA	5,463	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.8.3	Rapid Mix Tank	1	EA	4,500	5,000	VQ
1.3.8.4	Mixer	1	EA	2,500	3,000	VQ
1.3.9	Disc Filter	1	LS	108,750	109,000	VQ
1.3.10	Settled Water Storage Tank	1	LS	10,000	10,000	VQ
1.3.9.1	SW Effluent Pump	0	EA	0	0	VQ

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.11	Sludge Conditioning/Handling Equipment					
1.3.11.1	Sludge Storage Tank	1	LS	21,500	22,000	VQ
1.3.11.2	Sludge Transfer Pump to Filter Press	2	EA	16,875	34,000	VQ
1.3.11.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.11.4	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.11.5	Filter Press	1	EA	175,000	175,000	VQ
1.3.11.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ
1.3.12	Piping					
1.3.12.1	PVC - 1"	80	LF	9	1,000	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.12.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.12.3	PVC - 4"	300	LF	15	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.12.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.5	PVC - 8"	0	LF	33	0	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.12.6	PVC - 12"	0	LF	66	0	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.12.7	HDPE - 2"	0	LF	15	0	Note 11
1.3.12.8	HDPE - 4"	200	LF	23	5,000	Note 11
1.3.12.9	HDPE - 8"	0	LF	32	0	Note 11
1.3.12.10	Valves and Appurtenances	1	LS	6,600	7,000	Note 10
				Subtotal	*1,051,000*	
1.4	EXISTING WTP UPGRADE	1	LS	318,000	*318,000*	see Note 14
1.5	ELECTRICAL	1	LS	122,000	*122,000*	Note 7
1.6	INSTRUMENTATION and CONTROLS	1	LS	153,000	*153,000*	Note 7
	Capital Costs			**Subtotal**	**1,721,000**	
1.7	CONSTRUCTION PRORATES	1	LS	1,007,000	*1,007,000*	Note 12
	General Conditions (Overhead)[a]	20% of Total Cost		345,000		
	Contractor's Profit[b]	10% of Total Cost + GC		207,000		
	Scope and Bid Design Contingency[c]	20% of Total Cost + GC + Profit		455,000		
1.8	ENGINEERING COSTS	1	LS	520,000	*520,000*	Note 13
	Remedial Design	8% of Total Cost + Const Prorates		219,000		
	Project Management	5% of Total Cost + Const Prorates		137,000		
	Construction Management	6% of Total Cost + Const Prorates		164,000		
	CAPITAL COST			**Total**	**3,248,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Lime	375 gpm	gpm	541	203,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.2	Polymer	375 gpm	gpm	174	66,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.3	Acid	375 gpm	gpm	14	6,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*275,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	*27,000*	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	9	annual salary	38,100	343,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*680,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.1.4	Sludge Recycle	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.5	Sludge-to-Waste	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.6	Sludge Storage to Filter Press	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.1.7	Filtrate Return Pump	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.3.2	Chemical Feed Systems					
2.5.6.3.2.1	Lime Slaker System	2.5	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.2.2	Polymer Activation/Feed System	3	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.2.3	Sludge Polymer Activation/Feed System	1.5	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.3	Mixers					
2.5.6.3.3.1	Sludge Mixing Tank	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.2	Rapid Mix	10	HP	429/(HP*yr)	5,000	Note 6
2.5.6.3.3.3	Flocculation	4	HP	429/(HP*yr)	2,000	Note 6
2.5.6.3.3.4	Sludge Storage Tank	10	HP	429/(HP*yr)	5,000	Note 6

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.5.6.3.3.5	Clarifier Scraper Drive	2	HP	429/(HP*yr)	1,000	Note 6
2.5.6.3.4	Sludge Handling Equipment					
2.5.6.3.4.1	Filter Press	5	HP	429/(HP*yr)	3,000	Note 6
2.5.6.4	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*760,000*	
	Annual O&M Costs			**Subtotal**	**1,805,000**	
2.6	CONSTRUCTION PRORATES	1	LS	1,055,000	*1,055,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	361,000		
	Contractor's Profit[b]		10% of Total Cost + GC	217,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	477,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	172,000	*172,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	172,000		
	ANNUAL O&M COST			**Total**	**3,032,000**	

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

L Alternative 6c - Construct New Proprietary Microencapsulation/Precipitation ARD WTP (ARAR Waiver) (375 gpm)

This alternative would consist of the construction of a new ARD treatment plant. The treatment process would utilize a proprietary chemical silica reagent to encapsulate metal hydroxides. The formed particulate would be settled out within sedimentatin basins. The process train includes the chemical feed system; mix tanks; sedimentation basins; sludge tanks; and all pumps, instrumentation and appurtenances. Also included are annual O&M operations for the treatment plant including utilities, staff, administration, site snow removal, and weekly monitoring sampling and support.

Either Alternative 3a or 3b would be selected along with this alternative. Resultant sludge would be disposed at an onsite location. Either Alternative 3a or 3b would be selected along with this alternative. Total treatment capacity would be 375 gpm.

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	784	CY	10	8,000	PW
1.1.2	Fine Grading	790	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	261	CY	20	6,000	PW
1.1.4	Aggregate below SOG	261	CY	19	6,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	2,000	2,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*23,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	6400	SF	9	58,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	261	CY	250	66,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Sludge Storage Tank Foundation	17	CY	250	5,000	Means Cost Data (2001), 03310-240-4050
					129,000	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ
1.3.2	MicroEncapsulation Process Train, including:	1	LS	750,000	750,000	VQ
	metering equipment					
	chemical storage					
	chemical feed					
	sludge pumps/handling					
	piping					
1.3.3	Settled Water Storage Tank	1	LS	10,000	10,000	VQ
1.3.3.1	SW Effluent Pump	0	EA	25,000	0	VQ
1.3.4	Sludge Conditioning/Handling Equipment					
1.3.4.1	Sludge Storage Tank	1	LS	122,500	123,000	VQ
1.3.4.2	Sludge Transfer Pump to Filter Press	2	EA	16,875	34,000	VQ
1.3.4.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.4.4	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.4.5	Filter Press	1	EA	175,000	175,000	VQ
1.3.4.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ
1.3.5	Piping					
1.3.5.1	PVC - 1"	0	LF	9	0	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.5.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.5.3	PVC - 4"	100	LF	15	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4480

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.5.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.5	PVC - 8"	40	LF	33	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.5.6	PVC - 12"	0	LF	66	0	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.7	HDPE - 2"	0	LF	15	0	Note 11
1.3.5.8	HDPE - 4"	0	LF	23	0	Note 11
1.3.5.9	HDPE - 8"	600	LF	32	20,000	Note 11
1.3.5.10	Valves and Appurtenances	1	LS	15,000	15,000	Note 10
				Subtotal	*1,203,000*	
1.5	ELECTRICAL	1	LS	48,000	*48,000*	Note 7
1.6	INSTRUMENTATION and CONTROLS	1	LS	60,000	*60,000*	Note 7
	Capital Costs			**Subtotal**	**1,434,000**	
1.7	CONSTRUCTION PRORATES	1	LS	839,000	*839,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	287,000		
	Contractor's Profit [b]		10% of Total Cost + GC	173,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	379,000		
1.8	ENGINEERING COSTS	1	LS	433,000	*433,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	182,000		
	Project Management		5% of Total Cost + Const Prorates	114,000		
	Construction Management		6% of Total Cost + Const Prorates	137,000		
	CAPITAL COST			**Total**	**2,583,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Chemicals (inc. proprietary)	375 gpm	gpm	2150	807,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*807,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	27,000	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	8	annual salary	38,100	305,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*642,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day
2.5.6.3.2	Process Train	15	HP	429/(HP*yr)	7,000	Note 6
2.5.6.3.3	Sludge Handling Equipment					
2.5.6.3.3.1	Filter Press	6	HP	429/(HP*yr)	3,000	Note 6

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.5.6.4	Gas					
2.5.6.4.1	Evaporators	11	gpm	10,512/(gpm*yr)	119,000	see Note 14
2.5.6.5	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*848,000*	
	Annual O&M Costs			**Subtotal**	**2,387,000**	
2.6	CONSTRUCTION PRORATES	1	LS	1,396,000	*1,396,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	478,000		
	Contractor's Profit [b]		10% of Total Cost + GC	287,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	631,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	227,000	*227,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	227,000		
	ANNUAL O&M COST			**Total**	**4,010,000**	

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD/KO*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final FFS (-30% to +50%)*

M **Alternative 6d - Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (ARAR Waiver) (375 gpm)**

Includes the construction of a newWTP located south of Strawberry Pond. Either Alternative 3a or 3b would be selected along with this alternative. Total treatment capacity equals 375 gpm.

The train would consist of chemical precipitation. A proprietary optimized chemical precipitation treatment train would be used to precipitate insoluble metal precipitates. Sludge residuals would be disposed of at an onsite location.

Treatment Capacity, gpm = 375 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	784	CY	10	8,000	PW
1.1.2	Fine Grading	790	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	261	CY	20	6,000	PW
1.1.4	Aggregate below SOG	261	CY	19	6,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	2,000	2,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*23,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	6400	SF	9	58,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building Foundation	261	CY	250	66,000	Means Cost Data (2001), 03310-240-4050
1.2.3	Concrete, Sludge Storage Tank Foundation	17	CY	250	5,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*129,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ
1.3.2	Optimized Process Train, including:	1	LS	1,462,750	1,463,000	VQ - Note 16
	pumps					
	chemical storage					
	chemical feed					
	membranes					
	piping					
	accessories					
	Electrical and I&C					
1.3.3	Settled Water Storage Tank	1	LS	10,000	10,000	VQ
1.3.4	Sludge Conditioning/Handling Equipment					
1.3.4.1	Sludge Storage Tank	1	LS	122,500	123,000	VQ
1.3.4.2	Sludge Transfer Pump to Filter Press	2	EA	16,875	34,000	VQ
1.3.4.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ
1.3.4.4	Polymer Activation/Feed System	1	EA	6,500	7,000	VQ
1.3.4.5	Filter Press	1	EA	175,000	175,000	VQ
1.3.4.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.5	Piping					
1.3.5.1	PVC - 1"	0	LF	9	0	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.5.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.5.3	PVC - 4"	100	LF	15	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.5.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.5	PVC - 8"	40	LF	33	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.5.6	PVC - 12"	0	LF	66	0	Estimated from Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.7	HDPE - 2"	0	LF	15	0	Note 11
1.3.5.8	HDPE - 4"	0	LF	23	0	Note 11
1.3.5.9	HDPE - 8"	600	LF	32	20,000	Note 11
1.3.5.10	Valves and Appurtenances	1	LS	14,400	15,000	Note 10
				Subtotal	*1,916,000*	
1.4	ELECTRICAL	1	LS	48,000	*48,000*	Note 7
1.5	INSTRUMENTATION and CONTROLS	1	LS	60,000	*60,000*	Note 7
	Capital Costs			**Subtotal**	**2,147,000**	
1.6	CONSTRUCTION PRORATES	1	LS	1,255,000	*1,255,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	430,000		
	Contractor's Profit [b]		10% of Total Cost + GC	258,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	567,000		
1.7	ENGINEERING COSTS	1	LS	649,000	*649,000*	Note 13
	Remedial Design		8% of Total Cost + Const Prorates	273,000		
	Project Management		5% of Total Cost + Const Prorates	171,000		
	Construction Management		6% of Total Cost + Const Prorates	205,000		
	CAPITAL COST			**Total**	**3,928,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	Hydroxide	1	LS	65,000	65,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
2.1.2	Chemicals (inc. proprietary)	1	LS	75,000	75,000	VQ - costs calculated as a function of chemical cost and treatment flow rate
				Subtotal	*140,000*	
2.2	SAMPLING (inc. lab support)	1	LS	26,994	*27,000*	Note 5
2.3	STAFF					
2.3.1	Plant Engineer	1	annual salary	82,500	83,000	Note 5
2.3.2	Operators	8	annual salary	38,100	305,000	Note 5
2.3.3	Mechanic	2	annual salary	59,800	120,000	Note 5
2.3.4	Chemist	1	annual salary	39,600	40,000	Note 5
2.3.5	Security	2	annual salary	34,200	69,000	Note 5
2.3.6	Administrative Assistant	1	annual salary	25,000	25,000	Note 5
				Subtotal	*642,000*	
2.4	OTHER DIRECT COSTS					
2.4.1	Project Manager	1040	hours per year	40	42,000	Note 5
2.4.2	Junior Engineer	240	hours per year	30	8,000	Note 5
2.4.3	Project Engineer	240	hours per year	50	13,000	Note 5
				Subtotal	*63,000*	
2.5	INDIRECT COSTS					
2.5.1	Radio and Pager Rental	1	LS	2,000	2,000	Note 5
2.5.2	Vehicles					
2.5.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.5.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.5.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.5.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.5.2.5	Fuel	1	year	138,000	138,000	Use hourly costs associated with each Item at 8 hrs/day, 365 days/yr
2.5.3	Road Grading	4	per year	5,000	20,000	Note 5
2.5.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.5.5	Supplies	1	LS	131,800	132,000	Note 5
2.5.6	Utilities					
2.5.6.1	Water	1	LS	5,000	5,000	Note 5
2.5.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.5.6.3	Electrical					
2.5.6.3.1	Pumps					
2.5.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	8 hours per day average over year
2.5.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	24 hours/day, 365 days/year
2.5.6.3.1.3	Heap Leach Recirculating (On-Solution)	165	HP	429/(HP*yr)	41,000	October through April, 24 hours/day

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.5.6.3.2	Optimized Process Train	132.5	HP	429/(HP*yr)	57,000	Note 6
2.5.6.3.3	Sludge Handling Equipment					
2.5.6.3.3.1	Filter Press	6	HP	429/(HP*yr)	3,000	Note 6
2.5.6.4	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for safety factor
				Subtotal	*779,000*	
	Annual O&M Costs			**Subtotal**	**1,651,000**	
2.6	CONSTRUCTION PRORATES	1	LS	967,000	*967,000*	Note 12
	General Conditions (Overhead)[a]		20% of Total Cost	331,000		
	Contractor's Profit [b]		10% of Total Cost + GC	199,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	437,000		
2.7	ENGINEERING COSTS (Construction Management only)	1	LS	158,000	*158,000*	Note 13
	Construction Management		6% of Total Cost + Const Prorates	158,000		
	ANNUAL O&M COST			**Total**	**2,776,000**	

Appendix C
Water Balance Modeling

Gilt Edge Mine NPL Site

Feasibility Study Water Balance Modeling

A stochastic water balance model was developed and used for the Gilt Edge Mine NPL Site to estimate and evaluate surface water flows to the water treatment plant (WTP) based on assumed WTP rates for different remedial alternatives. A spreadsheet model was developed using Excel. The specific objectives of the modeling were to:

(1) Estimate annual and monthly runoff from primary disturbed/mining activity areas that is currently or will require treatment at the WTP.

(2) Use a stochastic approach for analysis of precipitation based on historic records, and for probabilistic estimation of runoff, water treatment requirements, water storage and changes in the Sunday Pit, and risk of contaminated water bypass of the WTP to Strawberry Creek.

Methods

Subareas/Drainage

Subareas/source areas generating water and chemicals currently reporting to the WTP were delineated using a 1 in. = 800 ft. topographic map, field reconnaissance, and previous subarea delineation based on the Priority 1 Site Water Management Report for the site (Water Management Consultants [WMC], 1999). The subareas delineated in the Site Water Management Report were modified somewhat based on detailed field observations and topography. The subarea boundaries were digitized and the areal extent of each subarea measured. Subarea boundaries and areal extents are shown in Figure 1. The total area of the site that is currently generating water reporting to the WTP is approximately 194 acres.

Surface water, drainage, and water movement on the Gilt Edge site can be divided into water derived from areas that currently report to the WTP, and water that does not report to the WTP. Sources of water can be divided into subareas for key locations, pits, ponds, and areas of activity that either report to the WTP or do not. The primary areas delineated on the site are the Heap Leach Pad, Stormwater Pond, upper Strawberry Creek, Anchor Hill Pit, Dakota Maid Pit, Sunday Pit, Process Area, Ponds C, D, and E, Ruby Waste Rock Pile and Pond, and Hoodoo Gulch.

Process water in and from the Heap Leach Pad is recirculated via evaporative spray onto the pad during warm months, and also pumped to the Surge Pond and Anchor Hill Pit. Water in the Anchor Hill Pit and the stormwater Pond is currently mixed process and ARD water. No water from these areas currently reports directly to the WTP, but the

Color Chart(s)

The following chart(s) contains color that does not appear on the scanned image(s).

N

300 0 300 600 Feet

CDM Federal Programs Corporation
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FIGURE 1

GILT EDGE MINE SITE
SURFACE WATER SUBBASINS

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model assumes that water in storage in Anchor Hill is pumped to Sunday Pit and must be treated.

Water from the Ruby Waste Rock pile drains to Ruby Pond, which is then pumped to Pond E. Much of the surface disturbed (including the crusher area) area at the top of the site between the Heap Leach Pad and Dakota Maid and Sunday Pits drains to Pond D. Water in Pond D drains to Pond E. Water in the Dakota Maid Pit has been pumped, and is also hydraulically connected, to the Sunday Pit. Water in the Sunday Pit can be pumped to Pond E, but water in both the Dakota Maid and Sunday Pits can discharge to groundwater and seep into Ponds D and E. All water in Pond E is pumped to the WTP.

Most of the water that drains to Pond C is generally nonimpacted water from a large subarea to the west of the site that includes the Process Area, and from the upper Strawberry Creek subarea. Runoff from the upper Strawberry Creek subarea is diverted around the Stormwater Pond and directed via an underground pipe to Pond C. Part of the water from Pond C is discharged directly to Strawberry Creek, and part of it is batch treated with lime. Therefore, Pond C water does not currently report to the WTP. For the purposes of modeling likely interim remedial action scenarios, however, 30% of the drainage reporting to Pond C (assuming this water is contaminated) was input to the WTP.

Drainage from Hoodoo Gulch also does not currently report to the WTP. For the purposes of modeling likely interim remedial action scenarios, however, 10 gpm from the Hoodoo Gulch drainage (assuming this water is contaminated) was input to the WTP

Water Balance

The annual water balance for the site can be summarized by the following equation:

$$P = R + I + ET$$

where:

P = precipitation
R = runoff
I = infiltration or loss to groundwater
ET = evapotranspiration

Assumptions include that the change in groundwater and soil storage is negligible and that all infiltration becomes groundwater, with the exception of infiltration into the lined heap leach pad.

Annual and monthly precipitation records for Lead, South Dakota (period of record from 1909 to 1999) from South Dakota State University were used to estimate precipitation inputs at Gilt Edge. The average annual precipitation depth in Lead is 26.9 in., ranging from 12.84 to 42.8 in. The annual and monthly precipitation series were evaluated using

a range of statistical distributions. A lognormal distribution provided a very good fit to the data (R^2 of 0.95 for annual series), and was therefore used for the stochastic modeling (Figure 2). The stochastic software package/Excel add-in "@Risk" was used to generate a lognormal distribution for precipitation based on the historic log10 mean and log10 standard deviation of the data for each month. The cumulative distributions and Monte Carlo simulation provided an estimate of the risk of exceeding (or conversely, not exceeding) specific precipitation depths in any given month and at the end of each year over a series of years.

Based on analysis of historic monthly data, a monthly (lag1) correlation coefficient of 0.64 was used for the correlation of precipitation from each month to the next month.

Average annual pan evaporation (approximately 19 inches) was taken from WMC (1999) based on four years of data from the nearby Golden Reward Mine. A factor of 0.7 was used (0.7 multiplied by 19 inches) to estimate annual average lake evaporation for the ponds and pits, to derive a value of 13 inches. Annual potential evapotranspiration (ET) was estimated to be approximately 41 inches (U.S. Department of Commerce, 1979). A factor of 0.3 was used (0.3 multiplied by 41 inches) to estimate annual average ET from subbasins to derive a value of 13 inches. Therefore, an annual ET value of 13 inches was used for all areas at the site. However, measurable ET only occurs during early summer to early fall (May through October). The monthly distribution of ET was estimated based on data from the Pactola Dam, approximately 15 miles southeast of the site. This monthly pattern was input to the model to estimate monthly losses, and is presented in Figure 3.

Infiltration losses to groundwater that do not discharge back to Strawberry Creek (do not eventually report to the WTP and are permanently lost from the system to deeper regional groundwater flow) were assumed to be approximately 10 gpm based on long-term baseflow rates in Strawberry Creek.

The water stored in the Sunday Pit at the end of month i was used as the starting storage for month i+1.

Outputs

The following outputs from the model were generated stochastically based on the stochastic precipitation input:

(1) Contaminated runoff that requires treatment

(2) Water storage in Sunday Pit at end of each month and year, given different assumed WTP rates (200, 250, 300, 400, 500, 600, 700, and 800)

(3) Bypass of contaminated runoff around the WTP given the WTP rates

(4) Time to dewater Sunday Pit given the WTP rates

(5) Risk of bypass of WTP given the WTP rates

A comparison was also made of the results using this stochastic model to water balance results obtained in the Priority 1 Site Water Management Report (WMC, 1999) for an average precipitation year, and to results based on observed data from operations at the site during the 1999 water year.

Results

Results of the stochastic modeling for each month of the 2001 year for a WTP flowrate of 300 gpm are presented in Tables 1 through 12. Results of modeling the risk of contaminated runoff requiring treatment for each month during 2001 are presented in Figure 4. The greatest runoff occurs during November through March, and the least during July. This is primarily a result of the greatest ET during July and almost no ET during November through March.

Water storage in Sunday Pit at the end of December 2001 for different WTP rates and a starting storage volume of 110,000,000 gallons (which also includes water in Anchor Hill Pit that is pumped to Sunday Pit) at the beginning of January 2001 is shown in Figure 5. Using the graphs, for example, there is approximately a 95% probability (risk) that approximately 57,000,000 gallons of water or less will remain in the pit at the end of 2001 at a WTP flowrate of 300 gpm. At a flowrate of 500 gpm, there is a 95% probability that approximately 26,000,000 gallons or less will remain in the pit at the end of 2001.

The time required to dewater the Sunday Pit given the different WTP rates is presented in Table 13. This table shows, for example, that at a WTP flowrate of 300 gpm, there is approximately a 90% probability that it would take 1.1 years or less to dewater the Sunday Pit (based on the starting volume of 110,000,000 gallons with Anchor Pit water). There is a 95% probability that it would take 2.1 years or less. These time periods are reduced to 0.7 years or less and 0.8 years or less, respectively, at a WTP flow rate of 500 gpm.

The risk of bypass of the WTP given the different WTP rates is presented in Table 14. This table shows, for example, that at a WTP flowrate of 300 gpm, there is approximately a 8% probability of any flow bypassing the WTP and entering Strawberry Creek. This risk is reduced to about 3% at a flowrate of 500 gpm.

Comparison to Other Water Balance Estimates

Results were compared to water balance results obtained in the Priority 1 Site Water Management Report (WMC, 1999) for an average precipitation year, and results based on

observed data from operations at the site during the 1999 water year (10/1/99 to 10/1/00). The comparison of primary input parameters and results is shown in Table 15.

The WMC report (1999) estimated that a net positive balance of approximately 74,189,400 gallons occurs under average annual flow conditions based on an annual average precipitation depth of 25 in. In general, they concluded that management of average annual inflows to the site is feasible by operating the water treatment plant continuously (at a clean water outflow of approximately 200 gpm).

Results of the stochastic model using and annual precipitation depth of 25 in. showed a net positive balance of approximately 75,869,200 gallons. This estimate is only 2% higher than the WMC estimate.

The stochastic model provides a slightly more conservative estimate of runoff amounts and the water balance (slightly more runoff and water accumulation) than the WMC estimate. The primary reason for this difference is the variable amounts of ET and infiltration loses (to groundwater) for different areas of the site used in the WMC water balance. The difference of 2% is considered an excellent validation of the stochastic model.

A simple water balance (Table 16) for the site for the 1999 water year (10/1/99 to 10/5/00) based on measured precipitation amounts and WTP flowrates was also performed and compared to results using the stochastic model (Table 15). The total precipitation measured at the Lead, South Dakota Homestake Mine station was 28.72 in. During this time, approximately 107,500,000 gallons were treated at the WTP (annual average WTP rate of approximately 205 gpm). This includes all runoff and 9,894,000 gallons dewatered from the King shaft. Results of the water balance indicated that runoff was 98,427,851 gallons.

Using an annual precipitation depth of 28.72 in., the stochastic model showed runoff of approximately 101,018,000 gallons. This is approximately 3% higher than the estimated runoff based on observed data from the site during the 1999 water year. The difference of 3% is considered a good validation of the stochastic model based on only one year of data.

Predictive Charts using the Simple Water Balance and Various Water Treatment Rates

Various ARD dewatering scenarios can be presented by varying precipitation and ARD treatment rates input into the 1999 water year balance. Precipitation and ARD treatment rates projected into the future are shown in relation to various site closure options. Twenty-four (24) site ARD dewatering scenarios have been developed and are presented in the charts. Chart 1a, 2a, 3a, through 12a a show site ARD dewatering based on the 1999 precipitation. Chart1b, 2b, 3b, through 12b show site ARD dewatering based on 1999 precipitation plus two (2) wet years occurring back to back (2002 and 2003).

Chart 1a through Chart 6b shows dewatering scenarios based on treating all ARD water in storage at the site. Chart 7a through 12b shows dewatering scenarios based on treating only ARD water stored in the Sunday Pit in addition to ARD generated throughout the site by monthly precipitation. This treatment scenario was considered since ARD water present in the Anchor Hill Pit is being treated using an innovative treatment technology. If this treatment technology is successful, 73 million gallons of ARD in storage could be dischargeable from the site. Results for the Anchor Hill Pit Lake treatability study will not be available until early 2002.

The following explains the labels, titles, and symbols for the simple water balance charts:

Title Block — The title block explains the overall scenario being depicted on the chart in accordance with the following options [options are numbered 1), 2), etc.]:

A. Total Water Treatment Rate: 1) 200 gpm, 2) 250 gpm, or 3) 350 gpm
B. ARD to be Treated: 1) all ARD onsite or 2) Sunday Pit ARD only
C. Changes in Operations: 1) no operation changes, 2) addition of filter press (addition 50 gpm removed), or 3) additional plant capacity, additional 100 gpm removed
D. Other Site Closure Impacts: 1) No Ruby Flow Reduction, 2) Ruby Residual Flowing of 15 gpm
E. Chart Number: 1) 1a through 12a (1999 precipitation), or 2) 1b through 12b (1999 precipitation plus two wet years)
F. Actual ARD Removal Rate: 1) 16 gpm, 2) 66 gpm, or 3) 166 gpm (note: this is the amount of ARD being removed from storage)

Top Horizontal Axis — The top horizontal axis displays the chart timeline (water years) from 1999 to 2005 with notes showing the assumed time that site operations or closure activities are initiated/completed. The notes used on the charts are further explained below:

Site Operation/Closure Notes designated on Project Timelime:

A. Sunday Pit Only (dewatering time if only Sunday Pit ARD is treated)
B. 1st Wet Year (95 percentile water year used)
C. Early Action – 50 gpm (additional 50 gpm ARD removal from filter press)
D. WTP – 350 gpm (350 gpm treatment plant goes on-line)
E. LDPE Lay-Down (Ruby Cap remedy commences)
F. Ruby – Variable gpm (Reduced ARD generation from Ruby Cap remedy)
G. 2nd Wet Year (95 percentile water year used)
H. King Shaft (Proposed remedial activities at the King Shaft)
I. Dakota Maid/Sunday Pit (Proposed remedial activities at Dakota Maid/ Sunday Pit)
J. Anchor Hill (Proposed remedial activities at Anchor Hill)

Bottom Horizontal Axis — The bottom horizontal axis displays the months and years of the water balance timeline from October 1999 to September 2005.

Left Vertical Axis — The left vertical axis is the scale that shows the volume of ARD in storage in units of gallons. The bars on the chart represent the volume of ARD in storage and should be read off of this axis.

Right Vertical Axis — The right vertical axis is the scale that shows the assumed monthly precipitation in units of inches. The diamond symbols on the chart represent the monthly precipitation in inches and should be read off of this axis.

The following gives a brief interpretation of the simple water balance charts:

Treat All ARD Waters (Chart 1a through Chart 6b)

Chart 1a – With no changes to the current operation and no Ruby flow reduction, only 8.8 million gallons of ARD are removed from storage on a yearly basis. This treatment scenario does not meet the site-wide remediation schedule.

Chart 1b – With two wet years back to back, this treatment scenario shows that ARD dewatering occurs much later and does not meet the site-wide remediation schedule.

Chart 2a – With the addition of a filter press (additional 50 gpm treatment rate) and no Ruby flow reduction, the site can be dewatered in January 2005. However, approximately 25 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario does not meet the site-wide remediation schedule.

Chart 2b – With two wet years back to back, this treatment scenario shows that ARD dewatering occurs much later and does not meet the site-wide remediation schedule.

Chart 3a – With the addition of a 100 gpm treatment and no Ruby flow reduction, the site can be dewatered in August 2003. Because of the increase treatment capacity, only 17 million gallons of ARD storage would be required to accommodate spring runoff and summer storms. This treatment scenario meets the site-wide remediation schedule.

Chart 3b – With two wet years back to back, this scenario shows that the site can be dewatered in November 2003. Although an additional three months of water treatment is required, this treatment scenario still meets the site-wide remediation schedule.

Chart 4a – Shows the impact of capping the Ruby Dump and no changes to the current operation. Although more ARD is removed from storage when compared to Chart 1a,

this treatment scenario still does not dewater the site nor meet the site-wide remediation schedule.

Chart 4b – With two wet years back to back, this treatment scenario shows that ARD dewatering occurs much later and does not meet the site-wide remediation schedule.

Chart 5a – Shows the impact of capping the Ruby Dump and the addition of a filter press (additional 50 gpm treatment rate). The site can be dewatered in February 2004 versus January 2005 (Chart 2a). Approximately 20 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario meets the site-wide remediation schedule.

Chart 5b – With two wet years back to back, this treatment scenario shows that the site can be dewatered in November 2004. Because of the delay in dewatering the site, this treatment scenario does not meet the site-wide remediation schedule.

Chart 6a – Shows the impact of capping the Ruby Dump and the addition of a 100 gpm treatment. The site can be dewatered in July 2003 versus August 2003. Because of the increase treatment capacity, only 11 million gallons of ARD storage would be required to accommodate spring runoff and summer storms. This treatment scenario meets the site-wide remediation schedule.

Chart 6b – With two wet years back to back, this scenario shows that the site can be dewatered in October 2003. Although an additional three months of water treatment is required, this treatment scenario still meets the site-wide remediation schedule.

Treat Sunday Pit ARD Water Only (Chart 7a through Chart 12b)

Chart 7a – With no changes to the current operation and no Ruby flow reduction, the Sunday Pit cannot be dewatered in accordance with remediation schedule.

Chart 7b – With two wet years back to back, this treatment scenario shows that ARD dewatering of the Sunday Pit occurs much later and does not meet the Sunday Pit remediation schedule.

Chart 8a – With the addition of a filter press (additional 50 gpm treatment rate) and no Ruby flow reduction, the Sunday Pit can be dewatered in January 2003. Approximately 25 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 8b – With two wet years back to back, this treatment scenario shows that dewatering of the Sunday Pit occurs in December 2003. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 9a – With the addition of a 100 gpm treatment and no Ruby flow reduction, the Sunday Pit can be dewatered in October 2002. Because of the increase treatment capacity, only 17 million gallons of ARD storage would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 9b – With two wet years back to back, this scenario shows that the Sunday Pit can be dewatered in November 2002. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 10a – Shows the impact of capping the Ruby Dump and no changes to the current operation. The Sunday Pit can be dewatered in December 2003. Approximately 25 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 10b – With two wet years back to back, this treatment scenario shows that ARD dewatering of the Sunday Pit occurs in November 2004. Because of the delay in dewatering the Sunday Pit, this treatment scenario does not meet the Sunday Pit remediation schedule.

Chart 11a – Shows the impact of capping the Ruby Dump and the addition of a filter press (additional 50 gpm treatment rate). The Sunday Pit can be dewatered in December 2002. Approximately 20 million gallons of ARD storage (i.e., pond, pit, or tank) would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 11b – With two wet years back to back, this treatment scenario shows that the Sunday Pit can be dewatered in September 2003. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 12a – Shows the impact of capping the Ruby Dump and the addition of a 100 gpm treatment. The Sunday Pit can be dewatered in October 2002. Approximately 11 million gallons of ARD storage would be required to accommodate spring runoff and summer storms. This treatment scenario meets the Sunday Pit remediation schedule.

Chart 12b – With two wet years back to back, this scenario shows that the Sunday Pit can be dewatered in November 2002. This treatment scenario meets the Sunday Pit remediation schedule.

References

U.S. Department of Commerce. 1979. Climatic Atlas of the United States.

Water Management Consultants. 1999. Gilt Edge Mine Priority 1 and Priority 2 Site Water Management Report.

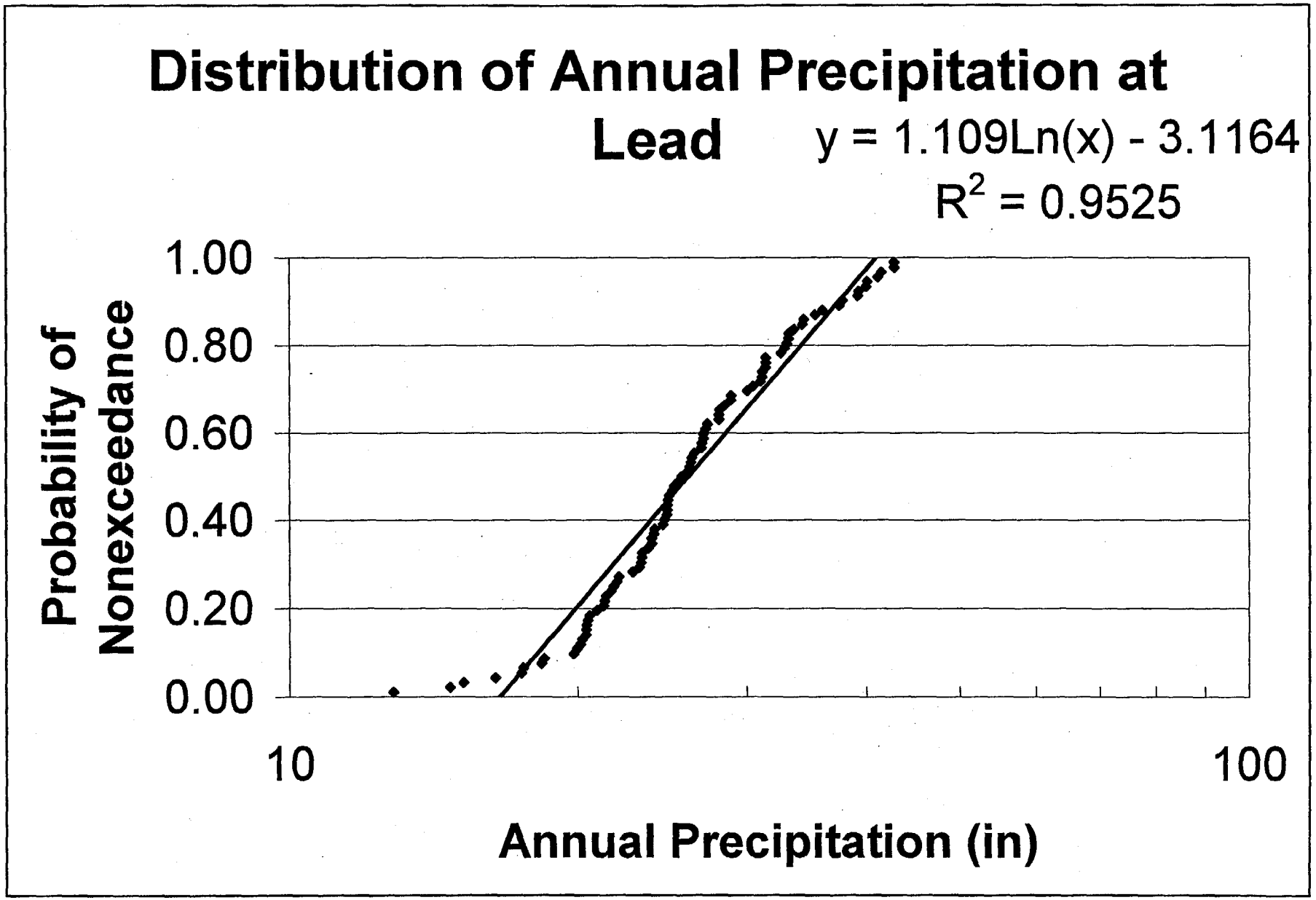

Distribution of Annual Precipitation at Lead
y = 1.109Ln(x) - 3.1164
R2 = 0.9525
Probability of Nonexceedance
1.00
0.80
0.60
0.40
0.20
0.00
10
100
Annual Precipitation (in)

Figure 2.

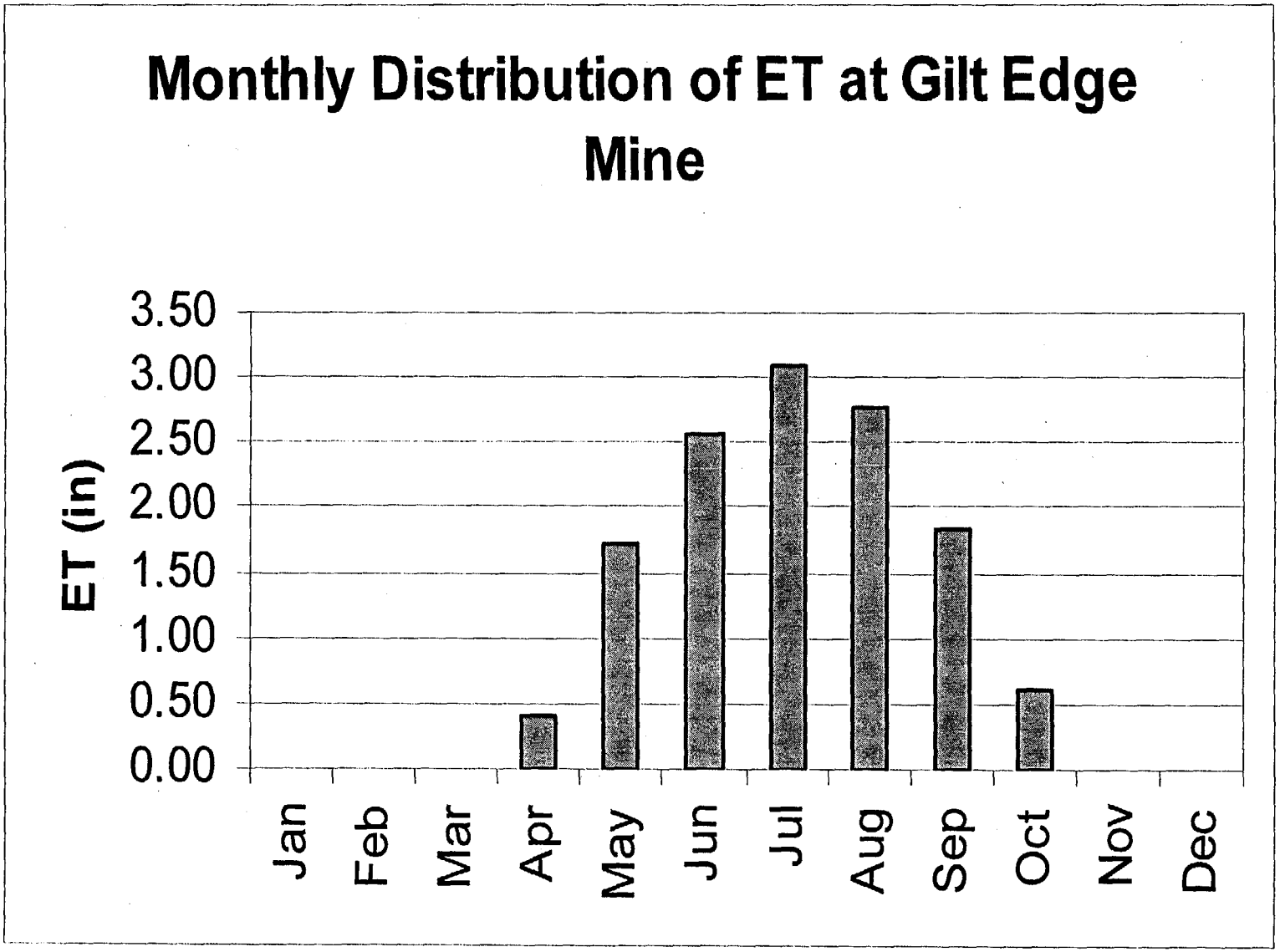

Monthly Distribution of ET at Gilt Edge Mine
ET (in)
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

Figure 3.

Figure 4.

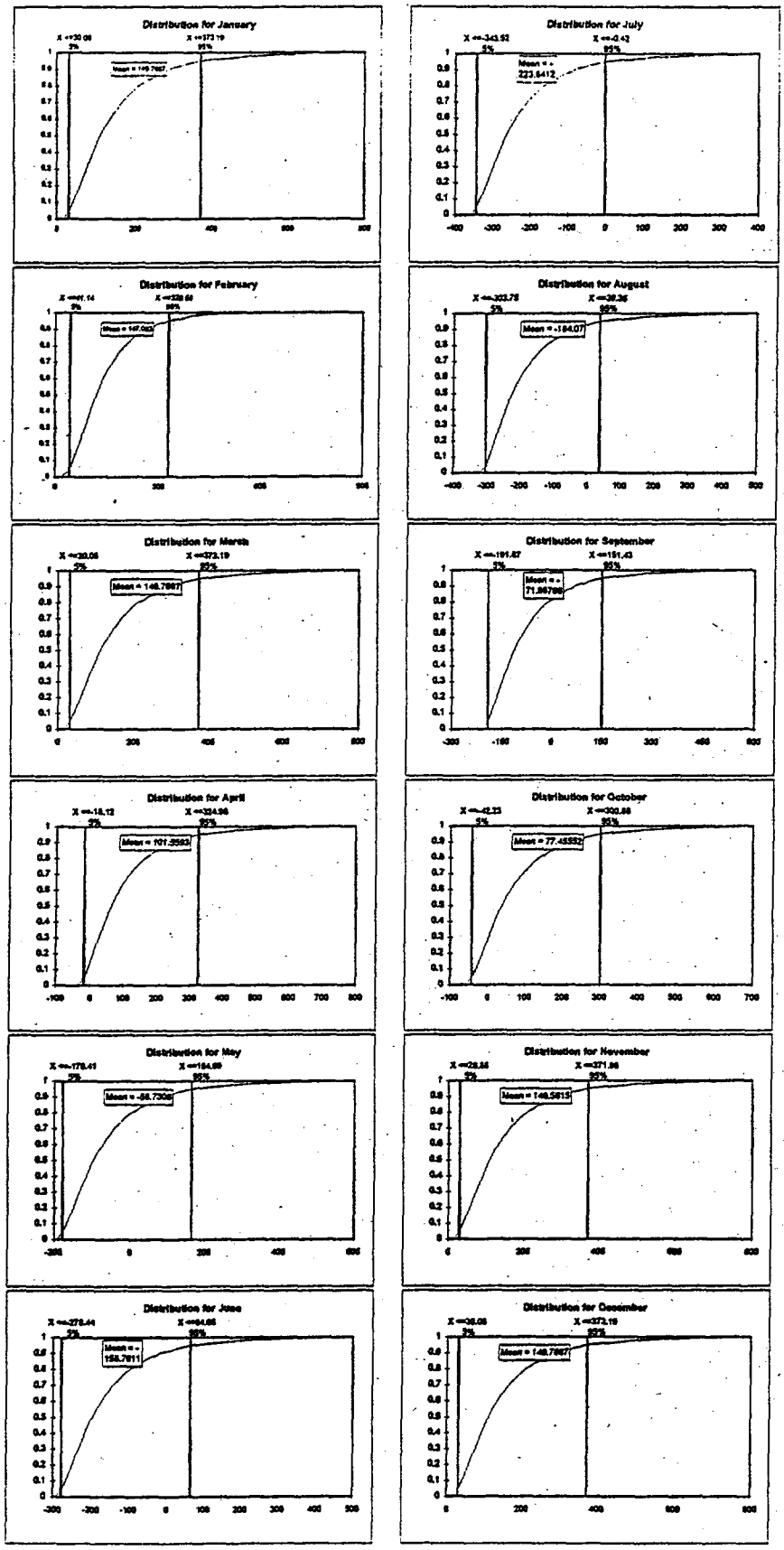
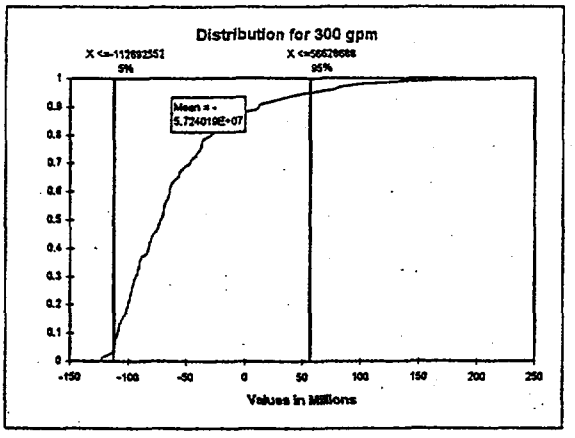
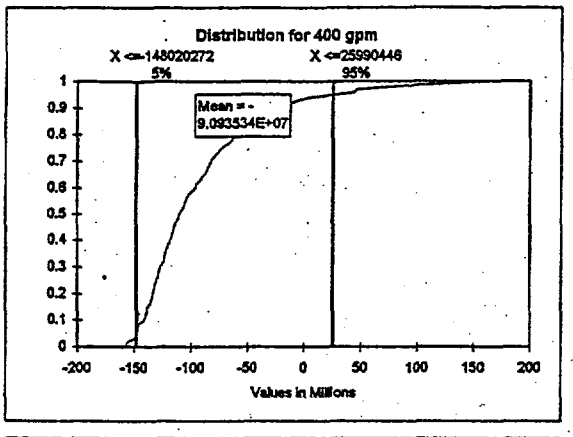
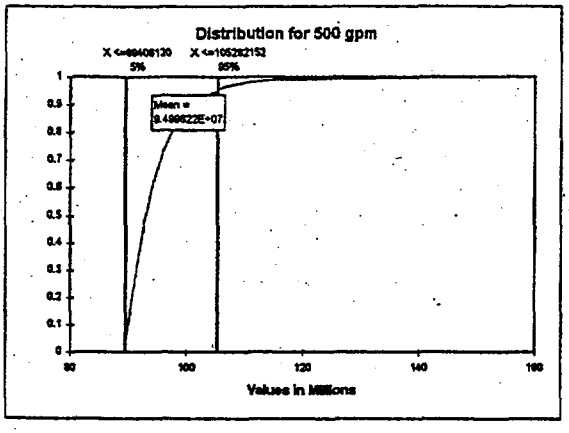

Distribution for January
Distribution for July
Distribution for February
Distribution for August
Distribution for March
Distribution for September
Distribution for April
Distribution for October
Distribution for May
Distribution for November
Distribution for June
Distribution for December

Figure 5.


Distribution for 300 gpm
X <=-112692552
5%
X <=56629688
95%
Mean =
5.724019E+07
Values in Millions


Distribution for 400 gpm
X <=-148020272
5%
X <=25990446
95%
Mean =
9.093534E+07
Values in Millions


Distribution for 500 gpm
X <=69406120
5%
X <=105282153
95%
Mean =
Values in Millions

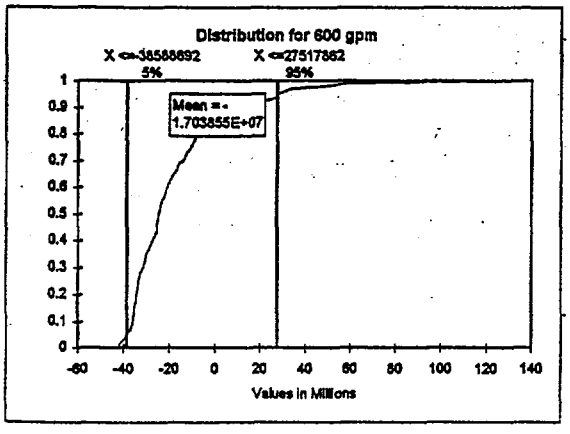

Distribution for 600 gpm
X <=-38588692
5%
X <=27517862
95%
Mean =
1.703855E+07
Values in Millions

Table 1. Gilt Edge Mine January water balance

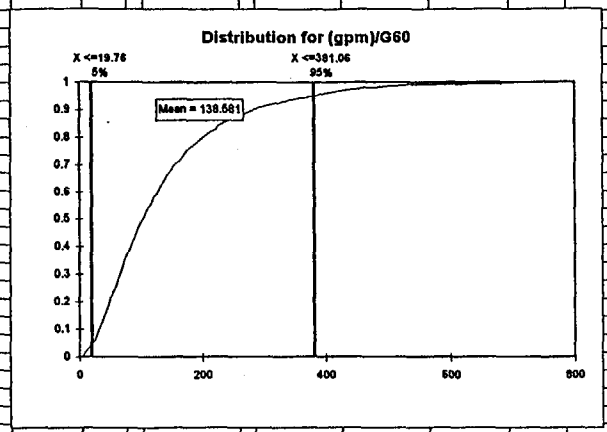
Mean January Precip =	1.20	in	Lead, Period of record = 1909-1999																												
Mean Log10 January Precip =	-0.03	in																													
St. Dev. =	0.85	in																													
St. Dev. Log10 =	0.33	in																													
ASSUMPTIONS:																															
Stochastic Precip.=	**3.67**	in	Assumed losses =			10%																									
ET =	**0**	in	Resulting losses from ET & GW =			2%																									
WTP Flow =	**300**	gpm	Resulting losses from assumed =			10%																									
SUBBASIN/	**TYPE**	**AREA**	**AREA**				**INPUTS**							**STORAGE**		**STORAGE**	**STORAGE**	**ESTIMATED LOSSES**								**OUTPUTS**						**TO**
LOCATION		**(ft2)**	**(ac)**	**Estimated**				**Measured**						**START**		**END**	**CHANGE**	**ET**	**GW**	**Assumed**		**Estimated based on ET & GW**				**Estimated based on assumed**			**Measured**			
				Precipitation			**GW**				**Type**																					
				(monthly)					(daily)	(weekly)								(monthly)		(monthly)		(monthly)				(monthly)				(daily)	(weekly)	
				(ft3)	(cfs)	(gpm)		(gpm)	(gallons)	(gallons)			(gallons)		(gallons)		(ft3)		(ft3)	(cfs)	(ft3)	(cfs)	(gpm)	(ft3)	(cfs)	(gpm)	(gpm)	(gallons)	(gallons)		
Leach Pad	process	1,263,936	29.0	386,914	0.1472	66							1,300,000				0		38,691	0.0147	386,914	0.1472	66	348,223	0.1325	59	238	342,857	2,400,000	j	Anchor Hill Pit
																															Stormwater Pond
Stormwater Pond	process	440,690	10.1	134,903	0.0513	23							10,400,000	z			0		13,496	0.0051	134,903	0.0513	23	121,413	0.0462	21					
													11,840,300	c	11,840,300		0														
Anchor Hill Pit	nonimpacted	665,039	15.3	203,581	0.0775	35			342,857	2,400,000	PT		161,700,000				0					0.0000	0			0					
													54,503,441	d	54,503,441	0															
Dakota Maid Pit	ARD	426,778	9.8	130,645	0.0497	22		86	123,840		GW	a	17,600,000				0		13,064	0.0050	130,645	0.0497	22	117,580	0.0447	20	76	109,093	1,763,650	g	Sunday Pit
													10	e	0	0													685,922		*Evaporative sprays*
Sunday Pit	**ARD**	**1,255,920**	**28.8**	**384,460**	**0.1463**	**66**			**109,093**	**763,650**	**PT**		**94,300,000**				**0**		**38,446**	**0.0146**	**384,460**	**0.1463**	**66**	**346,014**	**0.1317**	**59**					**Pond D & E via gw**
													110,000,000	**f**	**115,812,089**	**5,812,089**															**& seepage**
Pond C	nonimpacted	5,663,607	130.0	1,733,735	0.6597	296							860,300				0		173,373	0.0660	1,733,735	0.6597	296	1,560,361	0.5937	266					Batch
																															Strawberry Creek
Batch	nonimpacted																														Strawberry Creek
Pond D	ARD	1,787,872	41.0	547,301	0.2083	93							650,000				0		54,730	0.0208	547,301	0.2083	93	492,571	0.1874	84					Pond E
Pond E	**ARD**	**367,594**	**8.4**	**112,527**	**0.0428**	**19**							**1,000,000**				**0**		**11,253**	**0.0043**	**112,527**	**0.0428**	**19**	**101,275**	**0.0385**	**17**					**WTP**
																															Strawberry Creek
WTP	ARD	8,467,909	194.4					300	432,000		PT																200	288,000			Strawberry Creek
																											50	72,000			Sludge
Sludge																															**Sunday Pit**
Hoodoo Gulch		3,296,507	75.7	1,009,122	0.3840	172													100,912	0.0384	1,009,122	0.3840	172	908,210	0.3456	155					
Ruby Pond	**ARD**	**4,629,745**	**106.3**	**1,417,250**	**0.5393**	**242**		**27**	**38,880**		**SE**	**b**	**1,233,000**				**0**		**141,725**	**0.0539**	**1,417,250**	**0.5393**	**242**	**1,275,525**	**0.4854**	**218**					**WTP**
									37,728																						
Ruby Gulch																															
Seep flow																											13.6	19,584		h	
																												18,720			

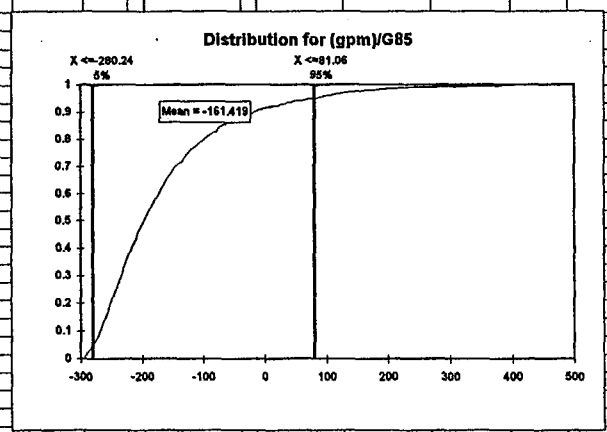
JANUARY		
CALCULATED TOTAL RUNOFF		
(monthly)		
(ft3)	(cfs)	(gpm)
675577	0.2671	116
617025	0.2348	105
608019	0.2314	104

includes all precip
includes ET & GW losses
includes assumed losses

CALCULATED WTP BYPASS		
(monthly)		
(ft3)	(cfs)	(gpm)
-1080978	-0.4114	-186
-1139530	-0.4336	-195
-1148536	-0.4370	-196

includes all precip
includes ET & GW losses
includes assumed losses





@RISK graph

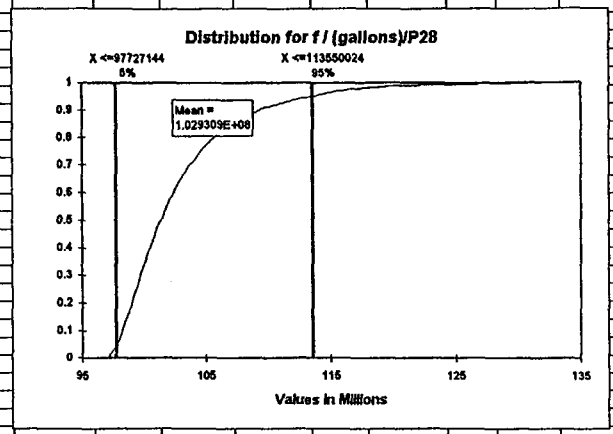


Table 2. Gilt Edge Mine February water balance

Mean February Precip =	1.20	in	Lead, Period of record = 1909-1999
Mean Log10 February Precip =	-0.01	in	
St. Dev. =	0.80	in	
St. Dev. Log10 =	0.28	in	
ASSUMPTIONS:			
Stochastic Precip.=	**0.83**	in	Assumed losses = 10%
ET =	0	in	Resulting losses from ET & GW = 10%
WTP Flow =	**300**	gpm	Resulting losses from assumed = 10%

SUBBASIN/ LOCATION	TYPE	AREA (ft2)	AREA (ac)	INPUTS: Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	Type		STORAGE START (gallons)	STORAGE END (gallons)	STORAGE CHANGE (gallons)	ESTIMATED LOSSES: ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	OUTPUTS: Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)		TO
Leach Pad	process	1,263,936	29.0	87,534	0.0333	15										0		8,753	0.0033	87,534	0.0333	15	78,781	0.0300	13	238	342,857	2,400,000	j	Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	30,520	0.0116	5							11,840,300	c 11,840,300	0	0		3,052	0.0012	30,520	0.0116	5	27,468	0.0105	5					*Stormwater Pond*
Anchor Hill Pit	nonimpacted	665,039	15.3	46,057	0.0175	8			342,857	2,400,000	PT					0					0.0000	0			0					
Dakota Maid Pit	ARD	426,778	9.8	29,557	0.0112	5		86	123,840		GW	a	54,503,441	d 54,503,441	0	0		2,956	0.0011	29,557	0.0112	5	26,601	0.0101	5	76	109,093	763,650	g	Sunday Pit
													0	e 0	0												685,922		*Evaporative sprays*
Sunday Pit	ARD	1,255,920	28.8	86,979	0.0331	15			109,093	763,650	PT		115,812,089	f 106,622,405	-9,189,684	0		8,698	0.0033	86,979	0.0331	15	78,281	0.0298	13					Pond D & E via gw
Pond C	nonimpacted	5,663,607	130.0	392,234	0.1493	67										0		39,223	0.0149	392,234	0.1493	67	353,011	0.1343	60					& seepage Batch
Batch	nonimpacted																													Strawberry Creek Strawberry Creek
Pond D	ARD	1,787,872	41.0	123,819	0.0471	21										0		12,382	0.0047	123,819	0.0471	21	111,437	0.0424	19					Pond E
Pond E	ARD	367,594	8.4	25,458	0.0097	4										0		2,546	0.0010	25,458	0.0097	4	22,912	0.0087	4					WTP
																														Strawberry Creek
WTP	ARD	8,467,909	194.4					300	432,000		PT															200	288,000			Strawberry Creek
																										50	72,000			Sludge
Sludge																														Sunday Pit
Hoodoo Gulch		3,296,507	75.7	228,300	0.0869	39												22,830	0.0087	228,300	0.0869	39	205,470	0.0782	35					
Ruby Pond	ARD	4,629,745	106.3	320,634	0.1220	55		27	38,880		SE	b				0		32,063	0.0122	320,634	0.1220	55	288,570	0.1098	49					WTP
									37,728																					
Ruby Gulch																														
Seep flow																										13.6	19,584		h	
																											18,720			

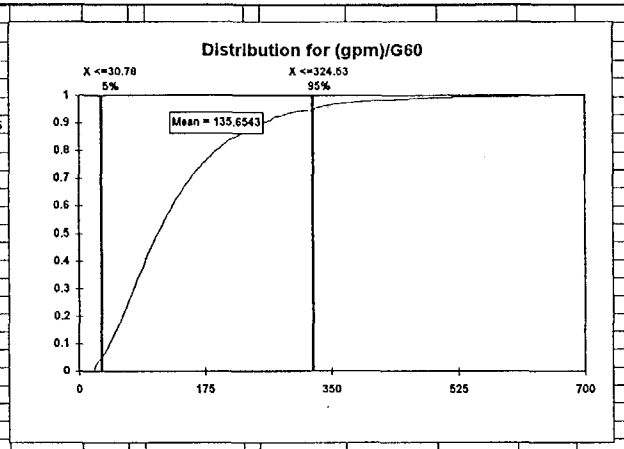
FEBRUARY

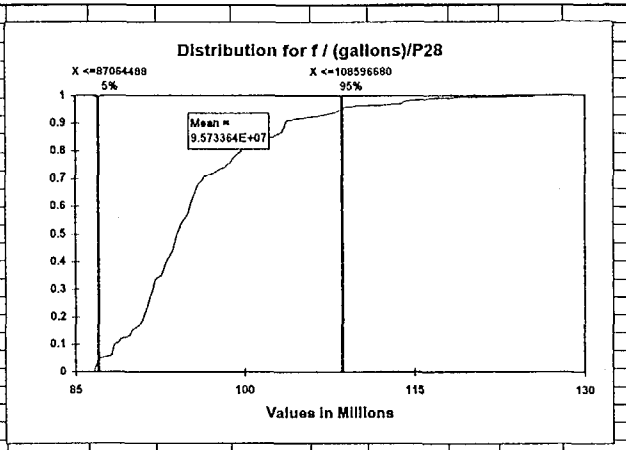
CALCULATED TOTAL RUNOFF

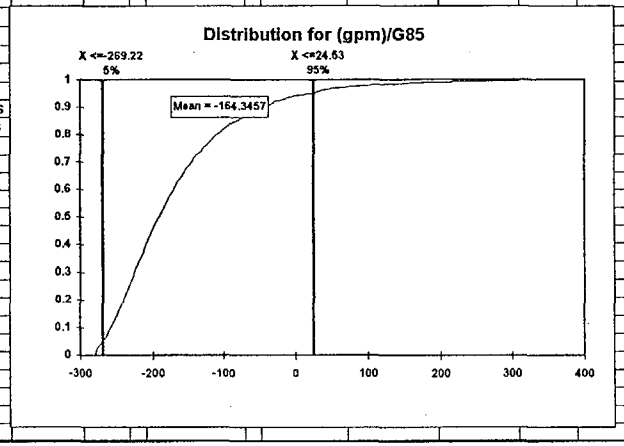
(monthly) (ft3)	(cfs)	(gpm)	
306501	0.1156	52	includes all precip
247949	0.0943	42	includes ET & GW losses
275851	0.1050	47	includes assumed losses

CALCULATED WTP BYPASS

(monthly) (ft3)	(cfs)	(gpm)	
-1450055	-0.5518	-248	includes all precip
-1508606	-0.5741	-258	includes ET & GW losses
-1480705	-0.5634	-253	includes assumed losses







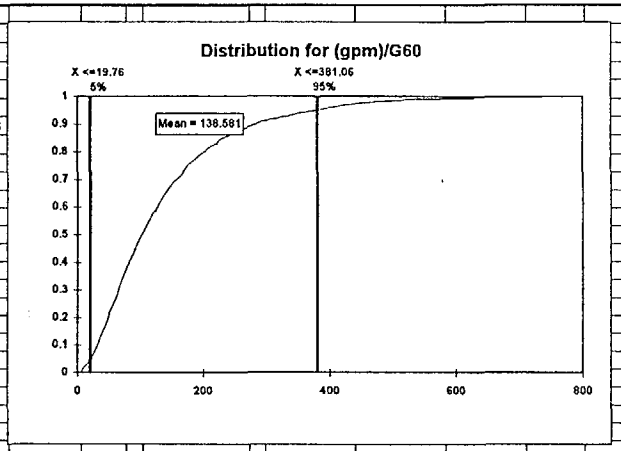
MARCH

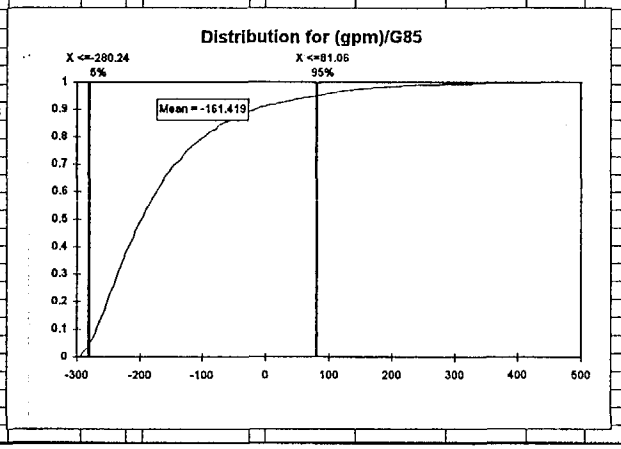
CALCULATED TOTAL RUNOFF

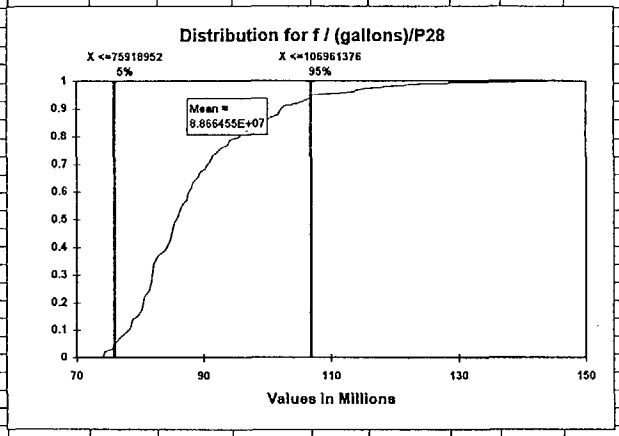
(monthly) (ft3)	(cfs)	(gpm)	
2378243	0.9050	406	includes all precip
2319691	0.8827	396	includes ET & GW losses
2140418	0.8145	366	includes assumed losses

CALCULATED WTP BYPASS

(monthly) (ft3)	(cfs)	(gpm)	
621687	0.2366	106	includes all precip
563136	0.2143	96	includes ET & GW losses
383863	0.1461	66	includes assumed losses



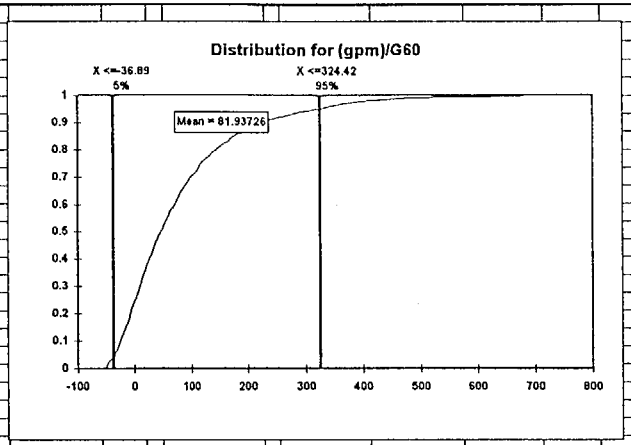


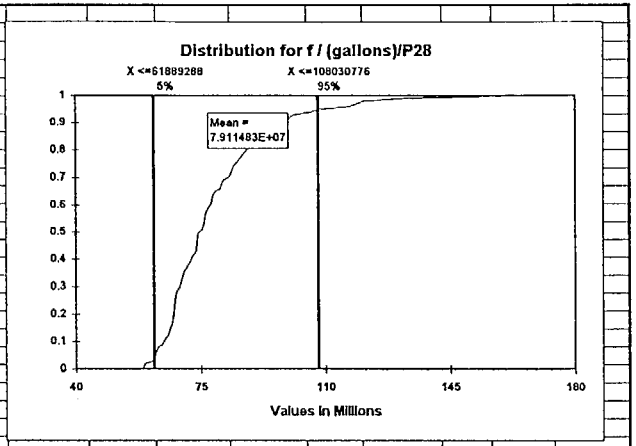


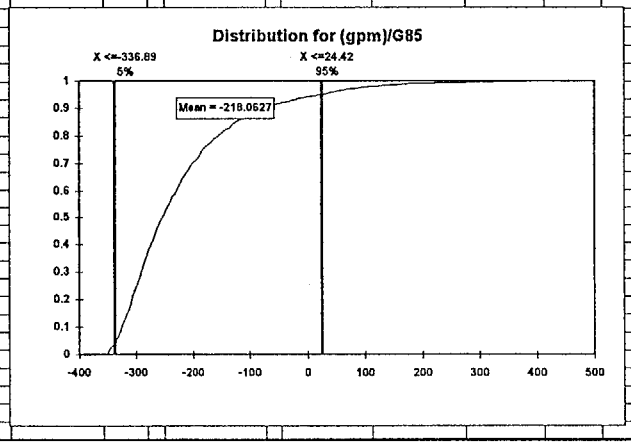
APRIL

CALCULATED TOTAL RUNOFF (monthly)			
(ft3)	(cfs)	(gpm)	
2431975	0.9254	415	includes all precip
2041764	0.7769	349	includes ET & GW losses
2188778	0.8328	374	includes assumed losses

CALCULATED WTP BYPASS (monthly)			
(ft3)	(cfs)	(gpm)	
675420	0.2570	115	includes all precip
285208	0.1085	49	includes ET & GW losses
432222	0.1645	74	includes assumed losses



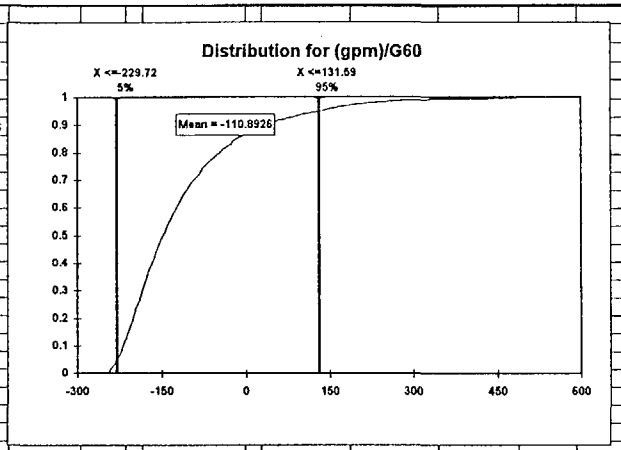


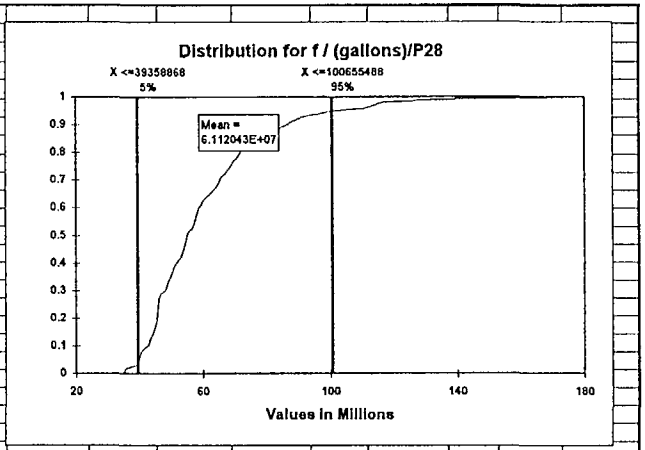


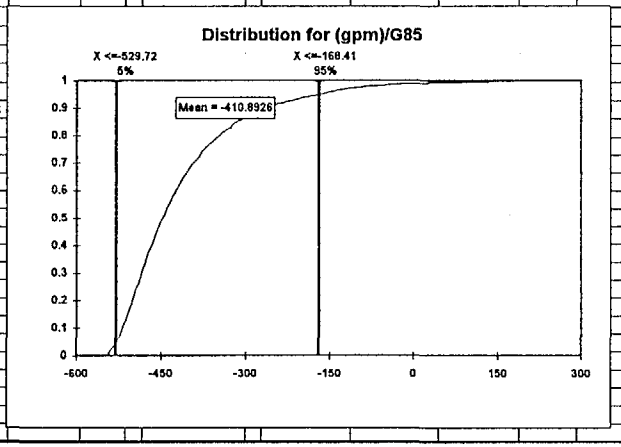
MAY

CALCULATED TOTAL RUNOFF (monthly) (ft3)	(cfs)	(gpm)	
147068	0.0580	25	includes all precip
-1372198	-0.5221	-234	includes ET & GW losses
132361	0.0504	23	includes assumed losses

CALCULATED WTP BYPASS (monthly) (ft3)	(cfs)	(gpm)	
-1609487	-0.6124	-275	includes all precip
-3128753	-1.1905	-534	includes ET & GW losses
-1624184	-0.6180	-277	includes assumed losses



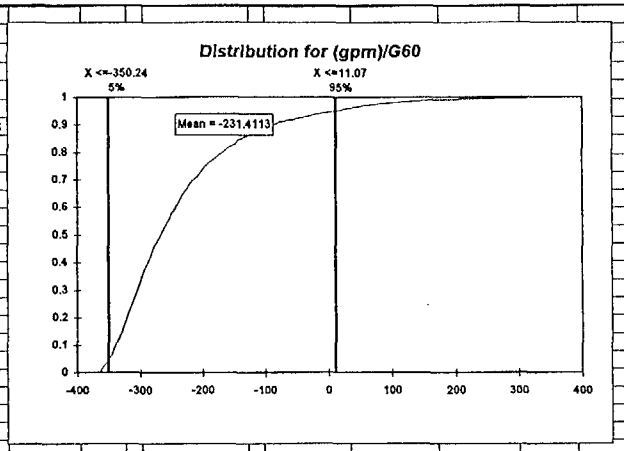


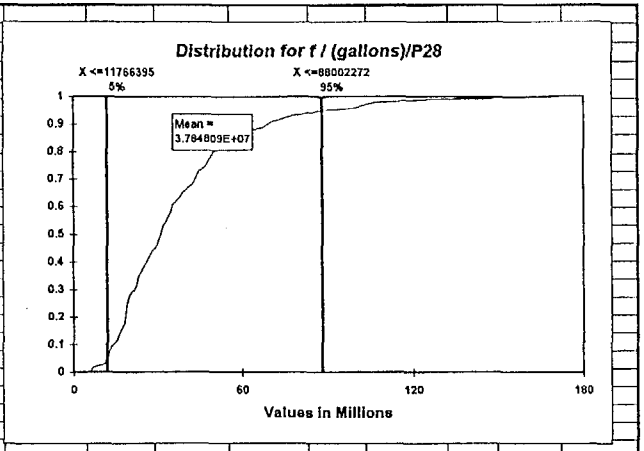


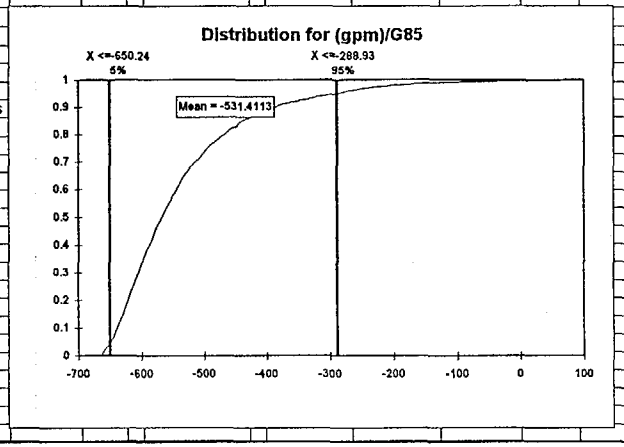
JUNE

CALCULATED TOTAL RUNOFF (monthly) (ft3)	(cfs)	(gpm)	
581876	0.2214	99	includes all precip
-1643049	-0.6252	-281	includes ET & GW losses
523689	0.1993	89	includes assumed losses

CALCULATED WTP BYPASS (monthly) (ft3)	(cfs)	(gpm)	
-1174678	-0.4470	-201	includes all precip
-3399604	-1.2936	-581	includes ET & GW losses
-1232867	-0.4691	-211	includes assumed losses



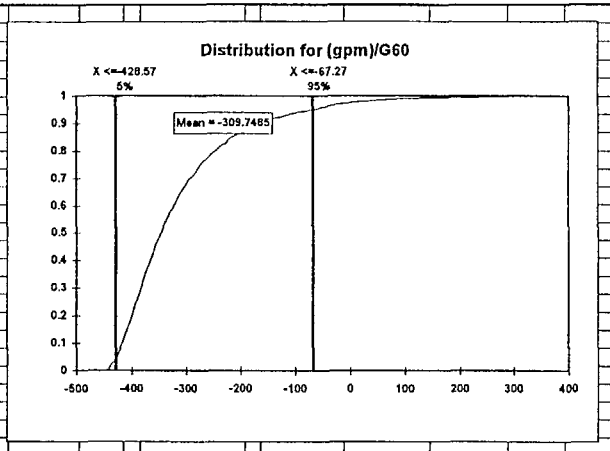


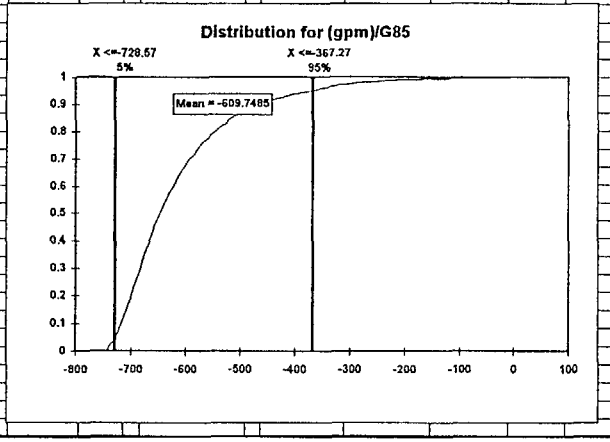


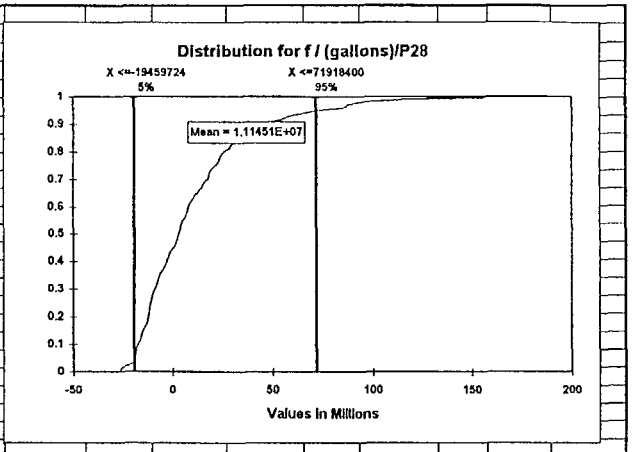
JULY

CALCULATED TOTAL RUNOFF (monthly)			
(ft3)	(cfs)	(gpm)	
556305	0.2117	95	includes all precip
-2127298	-0.8095	-363	includes ET & GW losses
500675	0.1905	86	includes assumed losses

CALCULATED WTP BYPASS (monthly)			
(ft3)	(cfs)	(gpm)	
-1200250	-0.4567	-205	includes all precip
-3883853	-1.4779	-663	includes ET & GW losses
-1255880	-0.4779	-214	includes assumed losses







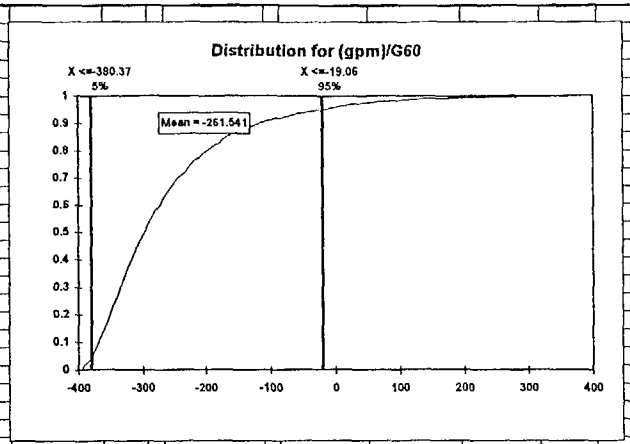
AUGUST

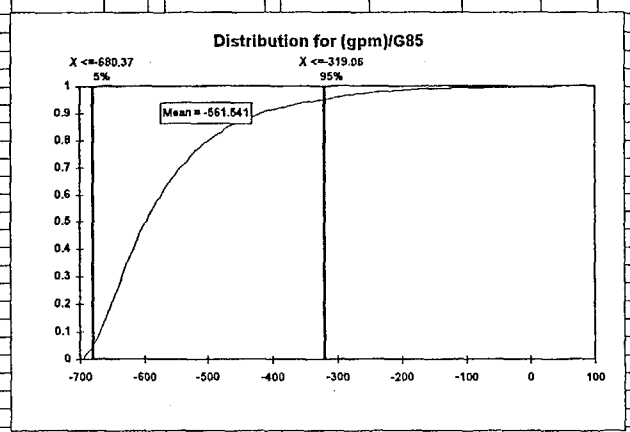
CALCULATED TOTAL RUNOFF

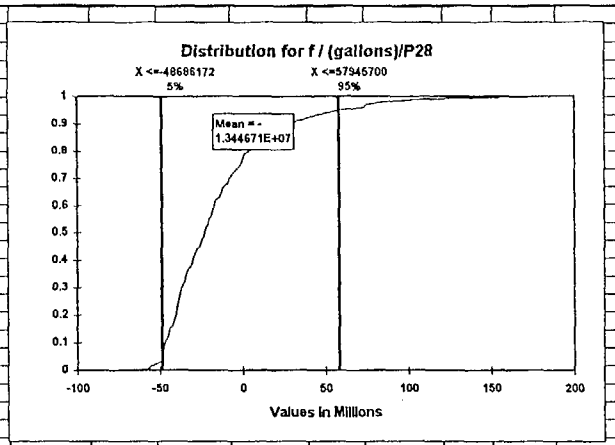
(monthly) (ft3)	(cfs)	(gpm)	
2164888	0.0238	370	Includes all precip
-236452	-0.0909	-40	Includes ET & GW losses
1948400	0.7414	333	Includes assumed losses

CALCULATED WTP BYPASS

(monthly) (ft3)	(cfs)	(gpm)	
408333	0.1554	70	Includes all precip
-1993007	-0.7584	-340	Includes ET & GW losses
191844	0.0730	33	Includes assumed losses







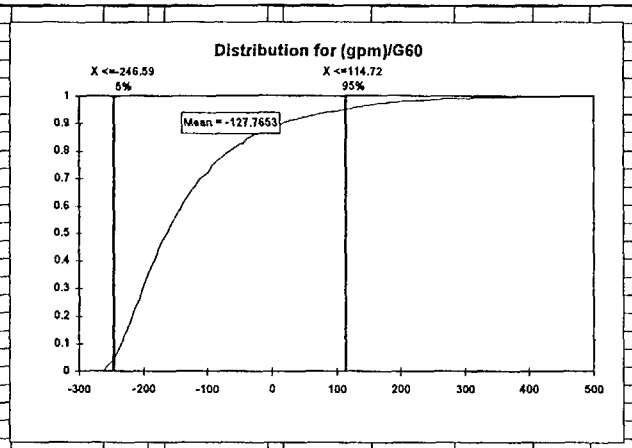
SEPTEMBER

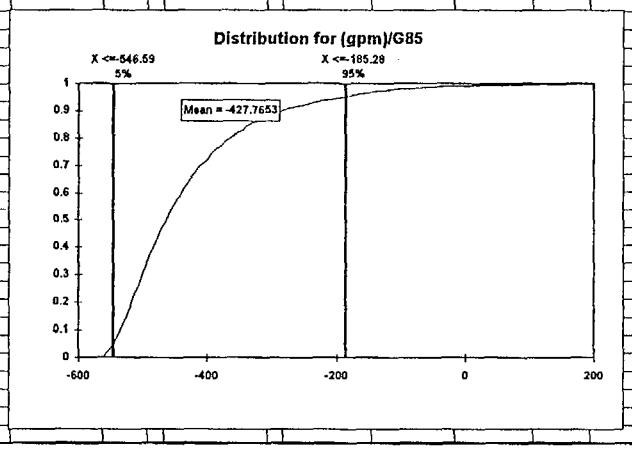
CALCULATED TOTAL RUNOFF

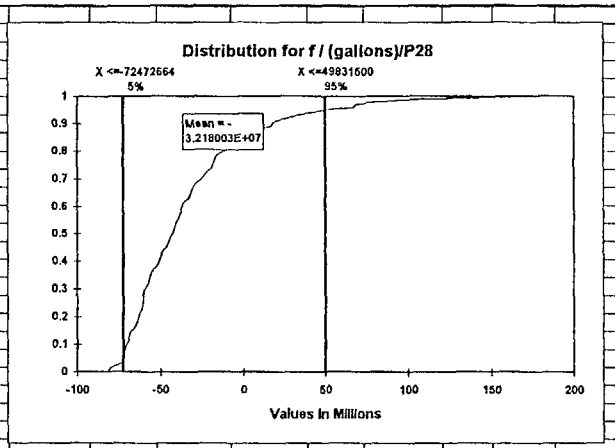
(monthly) (ft3)	(cfs)	(gpm)	
488398	0.1858	83	includes all precip
-1129661	-0.4299	-193	includes ET & GW losses
439558	0.1673	75	includes assumed losses

CALCULATED WTP BYPASS

(monthly) (ft3)	(cfs)	(gpm)	
-1268157	-0.4826	-217	includes all precip
-2886216	-1.0983	-493	includes ET & GW losses
-1316997	-0.5011	-225	includes assumed losses







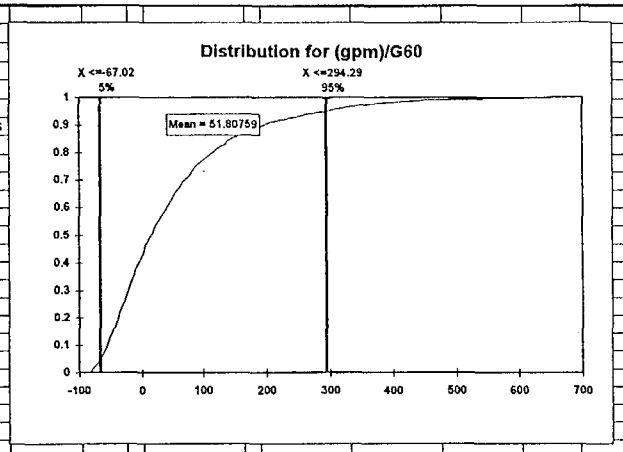
OCTOBER

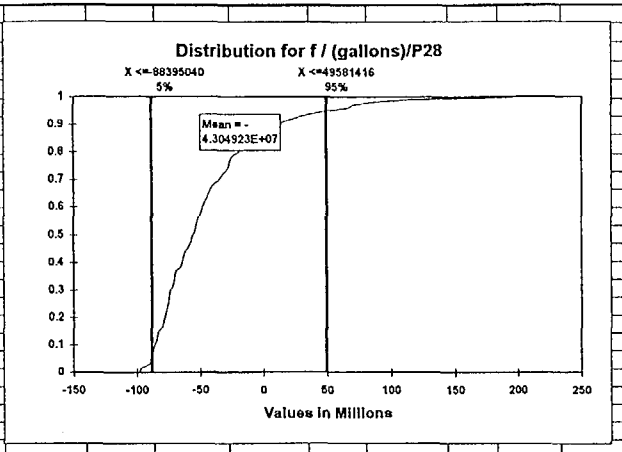
CALCULATED TOTAL RUNOFF

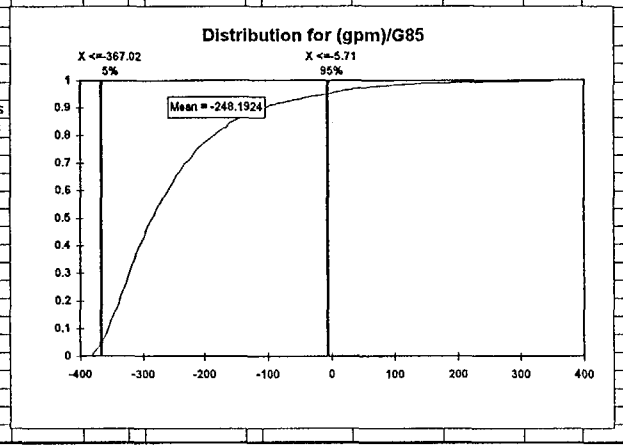
(monthly) (ft3)	(cfs)	(gpm)	
722724	0.2750	123	includes all precip
156098	0.0594	27	includes ET & GW losses
650452	0.2475	111	includes assumed losses

CALCULATED WTP BYPASS

(monthly) (ft3)	(cfs)	(gpm)	
-1033831	-0.3934	-177	includes all precip
-1600457	-0.6090	-273	includes ET & GW losses
-1106103	-0.4209	-189	includes assumed losses







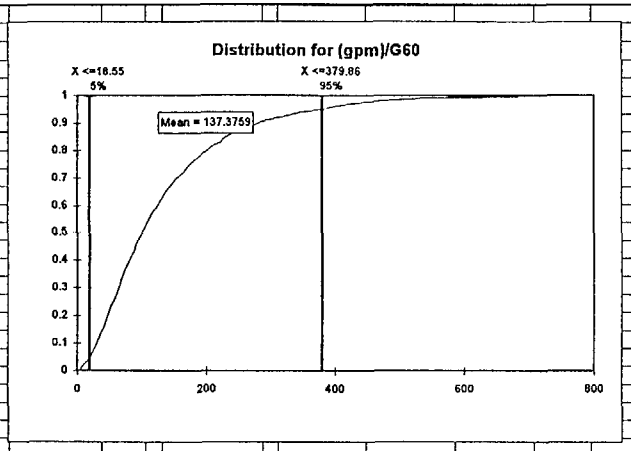
NOVEMBER

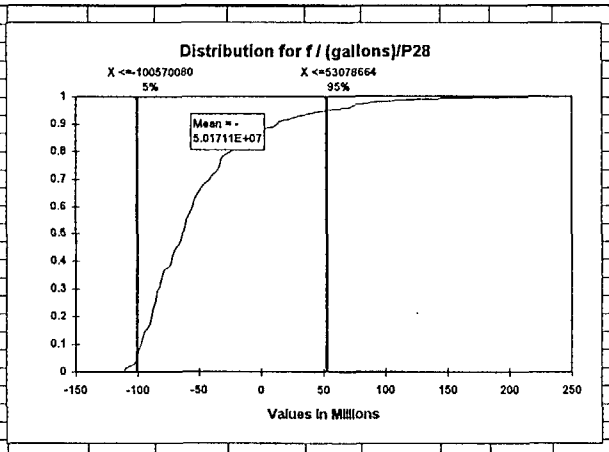
CALCULATED TOTAL RUNOFF

(monthly) (ft3)	(cfs)	(gpm)	
288212	0.1097	49	includes all precip
222603	0.0847	38	includes ET & GW losses
259391	0.0987	44	includes assumed losses

CALCULATED WTP BYPASS

(monthly) (ft3)	(cfs)	(gpm)	
-1468343	-0.5587	-251	includes all precip
-1533952	-0.5837	-262	includes ET & GW losses
-1497165	-0.5697	-256	includes assumed losses





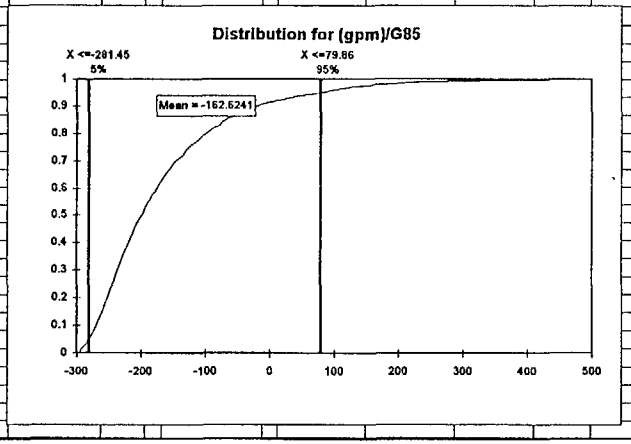


Table 3. Gilt Edge Mine March water balance

Mean March Precip =	2.04	in	Lead, Period of record = 1909-1999
Mean Log10 March Precip =	0.24	in	
St. Dev. =	1.28	in	
St. Dev. Log10 =	0.26	in	
ASSUMPTIONS:			
Stochastic Precip.=	0.78	in	Assumed losses = 10%
ET =	0	in	Resulting losses from ET & GW = 11%
WTP Flow =	300	gpm	Resulting losses from assumed = 10%

SUBBASIN/ LOCATION	TYPE	AREA (ft2)	AREA (ac)	INPUTS Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW (gpm)	Measured (daily) (gallons)	(weekly) (gallons)	Type	STORAGE START (gallons)	STORAGE END (gallons)	STORAGE CHANGE (gallons)	ESTIMATED LOSSES ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	OUTPUTS Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	TO
Leach Pad	process	1,263,936	29.0	82,450	0.0314	14								0		8,245	0.0031	82,450	0.0314	14	74,205	0.0282	13	238	342,857	2,400,000 j	Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5					11,840,300 c	11,840,300	0	0		2,875	0.0011	28,747	0.0109	5	25,873	0.0098	4				*Stormwater Pond*
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7		342,857	2,400,000	PT				0					0.0000	0			0				
Dakota Maid Pit	ARD	426,778	9.8	27,840	0.0106	5		123,840		GW a	54,503,441 d	54,503,441	0	0		2,784	0.0011	27,840	0.0106	5	25,056	0.0095	4	76	109,093	763,650 g	Sunday Pit
											0 e	0	0												685,922	*Evaporative sprays*
Sunday Pit	ARD	1,255,920	28.8	81,927	0.0312	14		109,093	763,650	PT				0		8,193	0.0031	81,927	0.0312	14	73,734	0.0281	13				Pond D & E via gw
											93,899,988 f	84,455,532	-9,444,456													& seepage
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63								0		36,945	0.0141	369,452	0.1406	63	332,506	0.1265	57				Batch
Batch	nonimpacted																										Strawberry Creek
Pond D	ARD	1,787,872	41.0	116,627	0.0444	20								0		11,663	0.0044	116,627	0.0444	20	104,965	0.0399	18				Strawberry Creek
Pond E	ARD	367,594	8.4	23,979	0.0091	4								0		2,398	0.0009	23,979	0.0091	4	21,581	0.0082	4				Pond D
WTP	ARD	8,467,909	194.4					300	432,000	PT																	WTP
																								200	288,000		Strawberry Creek
Sludge																								50	72,000		Sludge
																											Sunday Pit
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37										21,504	0.0082	215,040	0.0818	37	193,536	0.0736	33				
Ruby Pond	ARD	4,629,745	106.3	302,010	0.1149	52		27	38,880	SE b				0		30,201	0.0115	302,010	0.1149	52	271,809	0.1034	46				WTP
									37,728																		
Ruby Gulch																											
Seep flow																								13.6	19,584	h	
																									18,720		

Table 4. Gilt Edge Mine April water balance

Mean April Precip =	3.32 in	Lead, Period of record = 1909-1999	
Mean Log10 April Precip =	0.45 in		
St. Dev. =	1.78 in		
St. Dev. Log10 =	0.27 in		
ASSUMPTIONS:			
Stochastic Precip.=	**0.78** in	Assumed losses =	10%
ET =	**0.47** in	Resulting losses from ET & GW =	71%
WTP Flow =	**300** gpm	Resulting losses from assumed =	10%

SUBBASIN/ LOCATION	TYPE	AREA (ft2)	AREA (ac)	INPUTS: Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW (gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	Type	STORAGE START (gallons)	STORAGE END (gallons)	STORAGE CHANGE (gallons)	ESTIMATED LOSSES: ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	OUTPUTS: Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	TO
Leach Pad	process	1,263,936	29.0	82,450	0.0314	14									49,504		8,245	0.0031	32,946	0.0125	6	74,205	0.0282	13	238	342,857	2,400,000	j Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5									17,260		2,875	0.0011	11,487	0.0044	2	25,873	0.0098	4				*Stormwater Pond*
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7			342,857	2,400,000	PT	11,840,300 c	11,840,300	0	26,047					0.0000	0			0				
Dakota Maid Pit	**ARD**	**426,778**	**9.8**	**27,840**	**0.0106**	**5**		**86**	**123,840**		GW a	54,503,441 d	54,503,441	0	**16,715**		**2,784**	**0.0011**	**11,124**	**0.0042**	**2**	**25,056**	**0.0095**	**4**	**76**	**109,093**	**763,650**	g **Sunday Pit**
Sunday Pit	**ARD**	**1,255,920**	**28.8**	**81,927**	**0.0312**	**14**			**109,093**	**763,650**	PT	0 e	0	0	**49,190**		**8,193**	**0.0031**	**32,737**	**0.0125**	**6**	**73,734**	**0.0281**	**13**			**685,922**	*Evaporative sprays*
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63						**84,455,532** f	**72,530,450**	**-11,925,082**	221,825		36,945	0.0141	147,627	0.0562	25	332,506	0.1265	57				**Pond D & E via gw & seepage**
Batch	nonimpacted																											Batch Strawberry Creek
Pond D	**ARD**	**1,787,872**	**41.0**	**116,627**	**0.0444**	**20**									**70,025**		**11,663**	**0.0044**	**46,602**	**0.0177**	**8**	**104,965**	**0.0399**	**18**				Strawberry Creek
Pond E	**ARD**	**367,594**	**8.4**	**23,979**	**0.0091**	**4**									**14,397**		**2,398**	**0.0009**	**9,582**	**0.0036**	**2**	**21,581**	**0.0082**	**4**				**Pond E**
WTP	**ARD**	**8,467,909**	**194.4**					**300**	**432,000**		PT														**200**	**288,000**		**WTP**
Sludge																									**50**	**72,000**		Strawberry Creek Sludge
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37											21,504	0.0082	215,040	0.0818	37	193,536	0.0736	33				**Sunday Pit**
Ruby Pond	**ARD**	**4,629,745**	**106.3**	**302,010**	**0.1149**	**52**		**27**	**38,880**		SE b				**181,332**		**30,201**	**0.0115**	**120,678**	**0.0459**	**21**	**271,809**	**0.1034**	**46**				**WTP**
Ruby Gulch									37,728																			
Seep flow																									13.6	19,584		h
																										18,720		

Table 5. Gilt Edge Mine May water balance

Mean May Precip =	4.09	in	Lead, Period of record = 1909-1999
Mean Log10 May Precip =	0.51	in	
St. Dev. =	3.10	in	
St. Dev. Log10 =	0.30	in	
ASSUMPTIONS:			
Stochastic Precip.=	0.78	in	Assumed losses = 10%
ET =	2.07	in	Resulting losses from ET & GW = 275%
WTP Flow =	300	gpm	Resulting losses from assumed = 10%

SUBBASIN/				INPUTS							STORAGE	STORAGE	STORAGE	ESTIMATED LOSSES			OUTPUTS								TO
LOCATION	TYPE	AREA (ft2)	AREA (ac)	Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	Type	START (gallons)	END (gallons)	CHANGE (gallons)	ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	
Leach Pad	process	1,263,936	29.0	82,450	0.0314	14									218,029		8,245	0.0031	-135,579	-0.0516	-23	74,205	0.0282	13	238	342,857	2,400,000	j Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5									76,019		2,875	0.0011	-47,272	-0.0180	-8	25,873	0.0098	4				*Stormwater Pond*
												11,840,300 c	11,840,300	0													
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7			342,857	2,400,000	PT				114,719					0.0000	0			0				
												54,503,441 d	54,503,441	0													
Dakota Maid Pit	**ARD**	**426,778**	**9.8**	**27,840**	**0.0106**	**5**		**86**	**123,840**		**GW a**				**73,619**		**2,784**	**0.0011**	**-45,779**	**-0.0174**	**-8**	**25,056**	**0.0095**	**4**	**76**	**109,093**	**763,650** g	**Sunday Pit**
												0 e	0	0												**685,922**	*Evaporative sprays*
Sunday Pit	**ARD**	**1,255,920**	**28.8**	**81,927**	**0.0312**	**14**			**109,093**	**763,650**	**PT**				**216,646**		**8,193**	**0.0031**	**-134,719**	**-0.0513**	**-23**	**73,734**	**0.0281**	**13**				**Pond D & E via gw**
												72,530,450 f	52,160,682	-20,369,768													**& seepage**
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63									976,972		36,945	0.0141	-607,521	-0.2312	-104	332,506	0.1265	57				Batch
Batch	nonimpacted																										Strawberry Creek
																											Strawberry Creek
Pond D	**ARD**	**1,787,872**	**41.0**	**116,627**	**0.0444**	**20**									**308,408**		**11,663**	**0.0044**	**-191,780**	**-0.0730**	**-33**	**104,965**	**0.0399**	**18**				**Pond E**
Pond E	**ARD**	**367,594**	**8.4**	**23,979**	**0.0091**	**4**									**63,410**		**2,398**	**0.0009**	**-39,431**	**-0.0150**	**-7**	**21,581**	**0.0082**	**4**				**WTP**
WTP	**ARD**	**8,467,909**	**194.4**					**300**	**432,000**		**PT**														**200**	**288,000**		Strawberry Creek
																									50	**72,000**		Sludge
Sludge																												**Sunday Pit**
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37											21,504	0.0082	215,040	0.0818	37	193,536	0.0736	33				
Ruby Pond	**ARD**	**4,629,745**	**106.3**	**302,010**	**0.1149**	**52**		**27**	**38,880**		**SE b**				**798,631**		**30,201**	**0.0115**	**-496,621**	**-0.1890**	**-85**	**271,809**	**0.1034**	**46**				**WTP**
									37,728																		
Ruby Gulch																											
Seep flow																									13.6	19,584	h	
																										18,720		

Table 6. Gilt Edge Mine June water balance

Mean June Precip =	4.02	in	Lead, Period of record = 1909-1999
Mean Log10 June Precip =	0.53	in	
St. Dev. =	2.29	in	
St. Dev. Log10 =	0.25	in	

ASSUMPTIONS:

Stochastic Precip.=	0.78	in	Assumed losses =	10%
ET =	3.07	*in*	*Resulting losses from ET & GW =*	403%
WTP Flow =	300	gpm	Resulting losses from assumed =	10%

SUBBASIN/ LOCATION	TYPE	AREA (ft2)	AREA (ac)	INPUTS: Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	Type		STORAGE START (gallons)		STORAGE END (gallons)	STORAGE CHANGE (gallons)		ESTIMATED LOSSES: ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	OUTPUTS: Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)		TO
Leach Pad	*process*	1,263,936	29.0	82,450	0.0314	14												323,357		8,245	0.0031	-240,907	-0.0917	-41	74,205	0.0282	13	238	342,857	2,400,000	j	*Anchor Hill Pit*
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5							11,840,300	c	11,840,300	0		112,743		2,875	0.0011	-83,996	-0.0320	-14	25,873	0.0098	4					*Stormwater Pond*
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7			342,857	2,400,000	PT							170,139					0.0000	0			0					
													54,503,441	d	54,503,441	0															
Dakota Maid Pit	**ARD**	**426,778**	**9.8**	**27,840**	**0.0106**	**5**		**86**	**123,840**		**GW**	**a**						**109,184**		**2,784**	**0.0011**	**-81,344**	**-0.0310**	**-14**	**25,056**	**0.0095**	**4**	**76**	**109,093**	**763,650**	**g**	**Sunday Pit**
													0	e	0	0														685,922		*Evaporative sprays*
Sunday Pit	**ARD**	**1,255,920**	**28.8**	**81,927**	**0.0312**	**14**			**109,093**	**763,650**	**PT**							**321,306**		**8,193**	**0.0031**	**-239,379**	**-0.0911**	**-41**	**73,734**	**0.0281**	**13**					**Pond D & E via gw**
													52,160,682	f	26,512,985	-25,647,697															& seepage
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63												1,448,939		36,945	0.0141	-1,079,488	-0.4108	-184	332,506	0.1265	57					Batch
																																Strawberry Creek
Batch	*nonimpacted*																															Strawberry Creek
Pond D	**ARD**	**1,787,872**	**41.0**	**116,627**	**0.0444**	**20**												**457,397**		**11,663**	**0.0044**	**-340,770**	**-0.1297**	**-58**	**104,965**	**0.0399**	**18**					**Pond E**
Pond E	**ARD**	**367,594**	**8.4**	**23,979**	**0.0091**	**4**												**94,043**		**2,398**	**0.0009**	**-70,064**	**-0.0267**	**-12**	**21,581**	**0.0082**	**4**					**WTP**
																																Strawberry Creek
WTP	**ARD**	**8,467,909**	**194.4**					**300**	**432,000**		**PT**																	**200**	**288,000**			Strawberry Creek
																												50	**72,000**			Sludge
Sludge																																**Sunday Pit**
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37														21,504	0.0082	215,040	0.0818	37	193,536	0.0736	33					
Ruby Pond	**ARD**	**4,629,745**	**106.3**	**302,010**	**0.1149**	**52**		**27**	**38,880**		**SE**	**b**	**1,233,000**					**1,184,443**		**30,201**	**0.0115**	**-882,433**	**-0.3358**	**-151**	**271,809**	**0.1034**	**46**					**WTP**
									37,728																							
Ruby Gulch																																
Seep flow																												13.6	19,584		h	
																													18,720			

Table 7. Gilt Edge Mine July water balance

Mean July Precip =	2.61 in	Lead, Period of record = 1909-1999	
Mean Log10 July Precip =	0.33 in		
St. Dev. =	1.68 in		
St. Dev. Log10 =	0.28 in		
ASSUMPTIONS:			
Stochastic Precip.=	0.78 in	Assumed losses =	10%
ET =	3.72 in	Resulting losses from ET & GW =	486%
WTP Flow =	300 gpm	Resulting losses from assumed =	10%

SUBBASIN/ LOCATION	TYPE	AREA (ft2)	AREA (ac)	INPUTS: Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	Type		STORAGE START (gallons)		STORAGE END (gallons)	STORAGE CHANGE (gallons)		ESTIMATED LOSSES: ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	OUTPUTS: Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)		TO
Leach Pad	process	1,263,936	29.0	82,450	0.0314	14												391,820		8,245	0.0031	-309,370	-0.1177	-53	74,205	0.0282	13	238	342,857	2,400,000	j	Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5												136,614		2,875	0.0011	-107,867	-0.0410	-18	25,873	0.0098	4					*Stormwater Pond*
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7			342,857	2,400,000	PT		11,840,300	c	11,840,300	0		206,162					0.0000	0			0						
Dakota Maid Pit	**ARD**	**426,778**	**9.8**	**27,840**	**0.0106**	**5**		**86**	**123,840**		**GW**	**a**	54,503,441	d	54,503,441	0		**132,301**		**2,784**	**0.0011**	**-104,461**	**-0.0397**	**-18**	**25,056**	**0.0095**	**4**	**76**	**109,093**	**763,650**	**g**	**Sunday Pit**
Sunday Pit	**ARD**	**1,255,920**	**28.8**	**81,927**	**0.0312**	**14**			**109,093**	**763,650**	**PT**		**0**	**e**	**0**	**0**		**389,335**		**8,193**	**0.0031**	**-307,408**	**-0.1170**	**-53**	**73,734**	**0.0281**	**13**			**685,922**		*Evaporative sprays* **Pond D & E via gw & seepage**
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63							**26,512,985**	**f**	**-2,565,366**	**-29,078,351**		1,755,718		36,945	0.0141	-1,386,267	-0.5275	**-237**	332,506	0.1265	**57**					Batch Strawberry Creek
Batch	nonimpacted																															Strawberry Creek
Pond D	**ARD**	**1,787,872**	**41.0**	**116,627**	**0.0444**	**20**												**554,240**		**11,663**	**0.0044**	**-437,613**	**-0.1665**	**-75**	**104,965**	**0.0399**	**18**					**Pond E**
Pond E	**ARD**	**367,594**	**8.4**	**23,979**	**0.0091**	**4**												**113,954**		**2,398**	**0.0009**	**-89,975**	**-0.0342**	**-15**	**21,581**	**0.0082**	**4**					**WTP**
WTP	**ARD**	**8,467,909**	**194.4**					**300**	**432,000**		**PT**																	200	288,000			Strawberry Creek
Sludge																												50	72,000			Strawberry Creek Sludge
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37														21,504	0.0082	215,040	0.0818	37	193,536	0.0736	33					**Sunday Pit**
Ruby Pond	**ARD**	**4,629,745**	**106.3**	**302,010**	**0.1149**	**52**		**27**	**38,880**		**SE**	**b**						**1,435,221**		**30,201**	**0.0115**	**-1,133,211**	**-0.4312**	**-194**	**271,809**	**0.1034**	**46**					**WTP**
Ruby Gulch									37,728																							
Seep flow																												13.6	19,584		h	
																													18,720			

Table 8. Gilt Edge Mine August water balance

Mean August Precip =	2.03 in	Lead, Period of record = 1909-1999	
Mean Log10 August Precip =	0.21 *in*		
St. Dev. =	1.34 in		
St. Dev. Log10 =	0.32 in		
ASSUMPTIONS:			
Stochastic Precip.=	**0.78** in	Assumed losses =	10%
ET =	**3.32** in	Resulting losses from ET & GW =	435%
WTP Flow =	**300** gpm	Resulting losses from assumed =	10%

SUBBASIN/	TYPE	AREA	AREA	INPUTS								STORAGE		STORAGE	ESTIMATED LOSSES			OUTPUTS							TO
LOCATION		(ft2)	(ac)	Estimated Precipitation			GW	Measured			Type	START		END	CHANGE	ET	GW	Assumed	Estimated based on ET & GW			Estimated based on assumed			Measured			
				(monthly) (ft3)	(cfs)	(gpm)		(gpm)	(daily) (gallons)	(weekly) (gallons)		(gallons)		(gallons)	(gallons)	(monthly) (ft3)		(monthly) (ft3) (cfs)	(monthly) (ft3)	(cfs)	(gpm)	(monthly) (ft3)	(cfs)	(gpm)	(gpm)	(daily) (gallons)	(weekly) (gallons)	
Leach Pad	process	1,263,936	29.0	82,450	0.0314	14										349,689		8,245 0.0031	-267,239	-0.1017	-46	74,205	0.0282	13	238	342,857	2,400,000	Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5										121,924		2,875 0.0011	-93,177	-0.0355	-16	25,873	0.0098	4				*Stormwater Pond*
												11,840,300	c	11,840,300	0													
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7			342,857	2,400,000	PT					183,994				0.0000	0			0				
												54,503,441	d	54,503,441	0													
Dakota Maid Pit	**ARD**	**426,778**	**9.8**	27,840	0.0106	5		86	123,840		GW	a				118,075		2,784 0.0011	-90,235	-0.0343	-15	25,056	0.0095	4	76	109,093	763,650	g **Sunday Pit**
												0	e	0	0												685,922	*Evaporative sprays*
Sunday Pit	**ARD**	**1,255,920**	**28.8**	81,927	0.0312	14			109,093	763,650	PT					347,471		8,193 0.0031	-265,544	-0.1010	-45	73,734	0.0281	13				**Pond D & E via gw**
												-2,565,366	f	-29,532,545	-26,967,179													**& seepage**
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63										1,566,931		36,945 0.0141	-1,197,480	-0.4557	-205	332,506	0.1265	57				Batch
																												Strawberry Creek
Batch	nonimpacted																											Strawberry Creek
Pond D	**ARD**	**1,787,872**	**41.0**	116,627	0.0444	20										494,645		11,663 0.0044	-378,017	-0.1438	-65	104,965	0.0399	18				**Pond E**
Pond E	**ARD**	**367,594**	**8.4**	23,979	0.0091	4										101,701		2,398 0.0009	-77,722	-0.0296	-13	21,581	0.0082	4				**WTP**
																												Strawberry Creek
WTP	**ARD**	**8,467,909**	**194.4**					300	432,000		PT														200	288,000		Strawberry Creek
																									50	72,000		Sludge
Sludge																												**Sunday Pit**
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37												21,504 0.0082	215,040	0.0818	37	193,536	0.0736	33				
Ruby Pond	**ARD**	**4,629,745**	**106.3**	302,010	0.1149	52		27	38,880		SE	b				1,280,896		30,201 0.0115	-978,886	-0.3725	-167	271,809	0.1034	46				**WTP**
									37,728																			
Ruby Gulch																												
Seep flow																									13.6	19,584		h
																										18,720		

Table 9. Gilt Edge Mine September water balance

Mean September Precip =	1.79	in	Lead, Period of record = 1909-1999
Mean Log10 September Precip	0.11	in	
St. Dev. =	1.29	in	
St. Dev. Log10 =	0.40	in	
ASSUMPTIONS:			
Stochastic Precip.=	0.78	in	Assumed losses = 10%
ET =	2.21	in	Resulting losses from ET & GW = 293%
WTP Flow =	300	gpm	Resulting losses from assumed = 10%

SUBBASIN/ LOCATION	TYPE	AREA (ft2)	AREA (ac)	INPUTS Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	Type		STORAGE START (gallons)		STORAGE END (gallons)		STORAGE CHANGE (gallons)	ESTIMATED LOSSES ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	OUTPUTS Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)		TO
Leach Pad	process	1,263,936	29.0	82,450	0.0314	14												232,775		8,245	0.0031	-150,325	-0.0572	-26	74,205	0.0282	13	238	342,857	2,400,000	j	Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5												81,160		2,875	0.0011	-52,413	-0.0199	-9	25,873	0.0098	4					*Stormwater Pond*
													11,840,300	c	11,840,300		0														
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7			342,857	2,400,000	PT							122,478					0.0000	0			0					
													54,503,441	d	54,503,441		0														
Dakota Maid Pit	**ARD**	**426,778**	**9.8**	**27,840**	**0.0106**	**5**		**86**	**123,840**		GW	a						**78,598**		**2,784**	**0.0011**	**-50,758**	**-0.0193**	**-9**	**25,056**	**0.0095**	**4**	**76**	**109,093**	**763,650**	g	**Sunday Pit**
													0	e	0		0												**685,922**		*Evaporative sprays*
Sunday Pit	**ARD**	**1,255,920**	**28.8**	**81,927**	**0.0312**	**14**			**109,093**	**763,650**	PT							**231,299**		**8,193**	**0.0031**	**-149,372**	**-0.0568**	**-26**	**73,734**	**0.0281**	**13**					**Pond D & E via gw**
													-29,532,545	f	-50,641,224		-21,108,678														**& seepage**
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63												1,043,048		36,945	0.0141	-673,596	-0.2563	-115	332,506	0.1265	57					Batch
																																Strawberry Creek
Batch	nonimpacted																															Strawberry Creek
Pond D	**ARD**	**1,787,872**	**41.0**	**116,627**	**0.0444**	**20**												**329,266**		**11,663**	**0.0044**	**-212,639**	**-0.0809**	**-36**	**104,965**	**0.0399**	**18**					**Pond E**
Pond E	**ARD**	**367,594**	**8.4**	**23,979**	**0.0091**	**4**												**67,699**		**2,398**	**0.0009**	**-43,719**	**-0.0166**	**-7**	**21,581**	**0.0082**	**4**					**WTP**
																																Strawberry Creek
WTP	**ARD**	**8,467,909**	**194.4**					**300**	**432,000**		PT																	**200**	**288,000**			Strawberry Creek
																												50	**72,000**			Sludge
Sludge																																**Sunday Pit**
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37														21,504	0.0082	215,040	0.0818	37	193,536	0.0736	33					
Ruby Pond	**ARD**	**4,629,745**	**106.3**	**302,010**	**0.1149**	**52**		**27**	**38,880**		SE	b						**852,645**		**30,201**	**0.0115**	**-550,635**	**-0.2095**	**-94**	**271,809**	**0.1034**	**46**					**WTP**
									37,728																							
Ruby Gulch																																
Seep flow																												13.6	19,584		h	
																													18,720			

Table 10. Gilt Edge Mine October water balance

Mean October Precip =	1.89 in	Lead, Period of record = 1909-1999	
Mean Log10 October Precip =	0.15 in		
St. Dev. =	1.68 in		
St. Dev. Log10 =	0.36 in		
ASSUMPTIONS:			
Stochastic Precip.=	0.78 in	Assumed losses =	10%
ET =	0.72 in	Resulting losses from ET & GW =	103%
WTP Flow =	300 gpm	Resulting losses from assumed =	10%

SUBBASIN/ LOCATION	TYPE	AREA (ft2)	AREA (ac)	INPUTS Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW (gpm)	Measured (daily) (gallons)	(weekly) (gallons)	Type		STORAGE START (gallons)		STORAGE END (gallons)	STORAGE CHANGE (gallons)	ESTIMATED LOSSES ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	OUTPUTS Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)		TO
Leach Pad	process	1,263,936	29.0	82,450	0.0314	14										75,836		8,245	0.0031	6,614	0.0025	1	74,205	0.0282	13	238	342,857	2,400,000	j	Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5						11,840,300	c	11,840,300	0	26,441		2,875	0.0011	2,306	0.0009	0	25,873	0.0098	4					*Stormwater Pond*
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7		342,857	2,400,000	PT		54,503,441	d	54,503,441	0	39,902					0.0000	0			0					
Dakota Maid Pit	ARD	426,778	9.8	27,840	0.0106	5	86	123,840		GW	a	0	e	0	0	25,607		2,784	0.0011	2,233	0.0008	0	25,056	0.0095	4	76	109,093	763,650	g	Sunday Pit
Sunday Pit	ARD	1,255,920	28.8	81,927	0.0312	14		109,093	763,650	PT						75,355		8,193	0.0031	6,572	0.0025	1	73,734	0.0281	13			685,922		*Evaporative sprays*
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63						-50,641,224	f	-63,885,788	-13,244,564	339,816		36,945	0.0141	29,635	0.0113	5	332,506	0.1265	57					Pond D & E via gw & seepage
Batch	nonimpacted																													Batch Strawberry Creek
Pond D	ARD	1,787,872	41.0	116,627	0.0444	20										107,272		11,663	0.0044	9,355	0.0036	2	104,965	0.0399	18					Strawberry Creek
Pond E	ARD	367,594	8.4	23,979	0.0091	4										22,056		2,398	0.0009	1,923	0.0007	0	21,581	0.0082	4					WTP
WTP	ARD	8,467,909	194.4				300	432,000		PT																200	288,000			Strawberry Creek
Sludge																										50	72,000			Strawberry Creek Sludge
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37												21,504	0.0082	215,040	0.0818	37	193,536	0.0736	33					Sunday Pit
Ruby Pond	ARD	4,629,745	106.3	302,010	0.1149	52	27	38,880		SE	b					277,785		30,201	0.0115	24,225	0.0092	4	271,809	0.1034	46					WTP
Ruby Gulch								37,728																						
Seep flow																										13.6	19,584		h	
																											18,720			

Table 11. Gilt Edge Mine November water balance

Mean November Precip =	1.45	in	Lead, Period of record = 1909-1999
Mean Log10 November Precip =	0.04	in	
St. Dev. =	1.05	in	
St. Dev. Log10 =	0.37	in	
ASSUMPTIONS:			
Stochastic Precip.=	**0.78**	in	Assumed losses = 10%
ET =	**0.01**	in	Resulting losses from ET & GW = 12%
WTP Flow =	**300**	gpm	Resulting losses from assumed = 10%

SUBBASIN/ LOCATION	TYPE	AREA (ft2)	AREA (ac)	INPUTS Estimated Precipitation (monthly) (ft3)	(cfs)	(gpm)	GW	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)	Type		STORAGE START (gallons)	STORAGE END (gallons)	STORAGE CHANGE (gallons)	ESTIMATED LOSSES ET (monthly) (ft3)	GW	Assumed (monthly) (ft3)	(cfs)	OUTPUTS Estimated based on ET & GW (monthly) (ft3)	(cfs)	(gpm)	Estimated based on assumed (monthly) (ft3)	(cfs)	(gpm)	Measured (gpm)	(daily) (gallons)	(weekly) (gallons)		TO
Leach Pad	process	1,263,936	29.0	82,450	0.0314	14										1,053		8,245	0.0031	81,396	0.0310	14	74,205	0.0282	13	238	342,857	2,400,000	j	Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	28,747	0.0109	5										367		2,875	0.0011	28,380	0.0108	5	25,873	0.0098	4					*Stormwater Pond*
Anchor Hill Pit	nonimpacted	665,039	15.3	43,382	0.0165	7			342,857	2,400,000	PT		11,840,300	c 11,840,300	0	554					0.0000	0			0					
Dakota Maid Pit	**ARD**	**426,778**	**9.8**	**27,840**	**0.0106**	**5**		**86**	**123,840**		GW	a	54,503,441	d 54,503,441	0	**356**		**2,784**	**0.0011**	**27,484**	**0.0105**	**5**	**25,056**	**0.0095**	**4**	**76**	**109,093**	**763,650**	g	**Sunday Pit**
Sunday Pit	**ARD**	**1,255,920**	**28.8**	**81,927**	**0.0312**	**14**			**109,093**	**763,650**	PT		0	e 0	0	**1,047**		**8,193**	**0.0031**	**80,880**	**0.0308**	**14**	**73,734**	**0.0281**	**13**			**685,922**		*Evaporative sprays*
Pond C	nonimpacted	5,663,607	130.0	369,452	0.1406	63							-63,885,788	f -73,383,023	-9,497,235	4,720		36,945	0.0141	364,732	0.1388	62	332,506	0.1265	57					**Pond D & E via gw & seepage**
Batch	nonimpacted																													Batch
																														Strawberry Creek
																														Strawberry Creek
Pond D	**ARD**	**1,787,872**	**41.0**	**116,627**	**0.0444**	**20**										**1,490**		**11,663**	**0.0044**	**115,138**	**0.0438**	**20**	**104,965**	**0.0399**	**18**					**Pond E**
Pond E	**ARD**	**367,594**	**8.4**	**23,979**	**0.0091**	**4**										**306**		**2,398**	**0.0009**	**23,673**	**0.0090**	**4**	**21,581**	**0.0082**	**4**					**WTP**
																														Strawberry Creek
WTP	**ARD**	**8,467,909**	**194.4**					**300**	**432,000**		PT															**200**	**288,000**			Strawberry Creek
																										50	**72,000**			Sludge
Sludge																														**Sunday Pit**
Hoodoo Gulch		3,296,507	75.7	215,040	0.0818	37												21,504	0.0082	215,040	0.0818	37	193,536	0.0736	33					
Ruby Pond	**ARD**	**4,629,745**	**106.3**	**302,010**	**0.1149**	**52**		**27**	**38,880**		SE	b				**3,858**		**30,201**	**0.0115**	**298,152**	**0.1135**	**51**	**271,809**	**0.1034**	**46**					**WTP**
Ruby Gulch									37,728																					
Seep flow																										13.6	19,584		h	
																											18,720			

Table 12. Gilt Edge Mine December water balance

Mean December Precip =	1.26	in	Lead, Period of record = 1909-1999
Mean Log10 December Precip =	0.01	in	
St. Dev. =	0.81	in	
St. Dev. Log10 =	0.30	in	
ASSUMPTIONS:			
Stochastic Precip.=	3.67	in	Assumed losses = 10%
ET =	0	in	Resulting losses from ET & GW = 2%
WTP Flow =	300	gpm	Resulting losses from assumed = 10%

SUBBASIN/	TYPE	AREA	AREA	INPUTS								STORAGE	STORAGE	STORAGE	ESTIMATED LOSSES			OUTPUTS								TO
LOCATION		(ft2)	(ac)	Estimated Precipitation			GW	Measured			Type	START	END	CHANGE	ET	GW	Assumed	Estimated based on ET & GW			Estimated based on assumed			Measured			
				(monthly) (ft3)	(cfs)	(gpm)		(gpm)	(daily) (gallons)	(weekly) (gallons)		(gallons)	(gallons)	(gallons)	(monthly) (ft3)		(monthly) (ft3)	(monthly) (ft3)	(cfs)	(gpm)	(monthly) (ft3)	(cfs)	(gpm)	(gpm)	(daily) (gallons)	(weekly) (gallons)	
Leach Pad	process	1,263,936	29.0	386,914	0.1472	66									0		38,691 0.0147	386,914	0.1472	66	348,223	0.1325	59	238	342,857	2,400,000	j Anchor Hill Pit
Stormwater Pond	process	440,690	10.1	134,903	0.0513	23									0		13,490 0.0051	134,903	0.0513	23	121,413	0.0462	21				*Stormwater Pond*
												11,840,300	c 11,840,300	0												
Anchor Hill Pit	nonimpacted	665,039	15.3	203,581	0.0775	35			342,857	2,400,000	PT				0				0.0000	0			0				
												54,503,441	d 54,503,441	0												
Dakota Maid Pit	**ARD**	**426,778**	**9.8**	**130,645**	**0.0497**	**22**		86	123,840		GW a				**0**		**13,064 0.0050**	**130,645**	**0.0497**	**22**	**117,580**	**0.0447**	**20**	**76**	**109,093**	**763,650**	g **Sunday Pit**
												0	e 0	0												685,922	*Evaporative sprays*
Sunday Pit	**ARD**	**1,255,920**	**28.8**	**384,460**	**0.1463**	**66**			109,093	763,650	PT				**0**		**38,446 0.0146**	**384,460**	**0.1463**	**66**	**346,014**	**0.1317**	**59**				**Pond D & E via gw**
												76,648,296	f 82,460,385	5,812,089													**& seepage**
Pond C	nonimpacted	5,663,607	130.0	1,733,735	0.6597	296									0		173,373 0.0660	1,733,735	0.6597	296	1,560,361	0.5937	266				Batch
																											Strawberry Creek
Batch	nonimpacted																										Strawberry Creek
Pond D	**ARD**	**1,787,872**	**41.0**	**547,301**	**0.2083**	**93**									**0**		**54,730 0.0208**	**547,301**	**0.2083**	**93**	**492,571**	**0.1874**	**84**				**Pond E**
Pond E	**ARD**	**367,594**	**8.4**	**112,527**	**0.0428**	**19**									**0**		**11,253 0.0043**	**112,527**	**0.0428**	**19**	**101,275**	**0.0385**	**17**				**WTP**
																											Strawberry Creek
WTP	**ARD**	**8,467,909**	**194.4**					**300**	**432,000**		PT													**200**	**288,000**		Strawberry Creek
																								50	**72,000**		Sludge
Sludge																											**Sunday Pit**
Hoodoo Gulch		3,296,507	75.7	1,009,122	0.3840	172											100,912 0.0384	1,009,122	0.3840	172	908,210	0.3456	155				
Ruby Pond	**ARD**	**4,629,745**	**106.3**	**1,417,250**	**0.5393**	**242**		**27**	**38,880**		SE b				**0**		**141,725 0.0539**	**1,417,250**	**0.5393**	**242**	**1,275,525**	**0.4854**	**218**				**WTP**
									37,728																		
Ruby Gulch																											
Seep flow																								13.6	19,584		h
																									18,720		

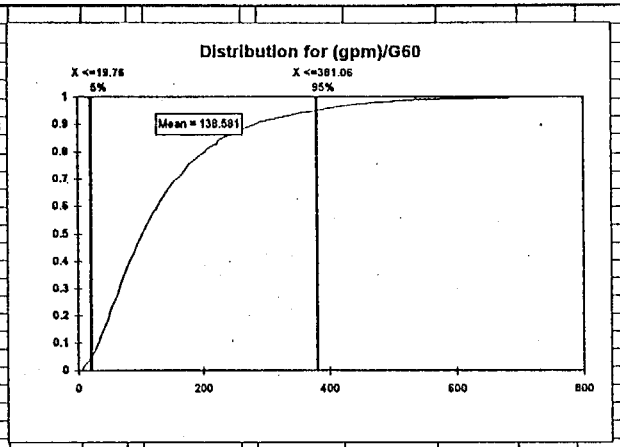
DECEMBER

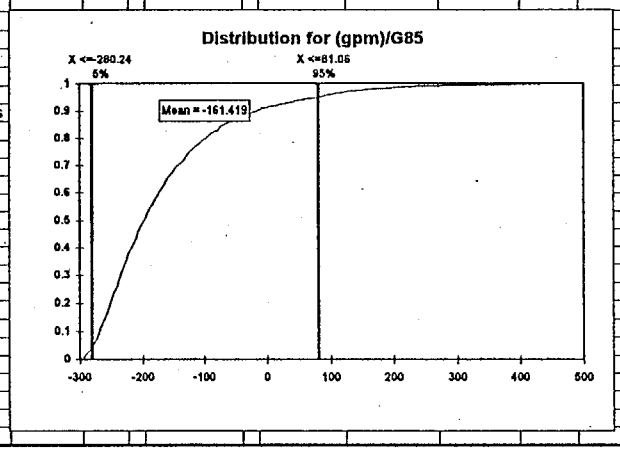
CALCULATED TOTAL RUNOFF

(monthly) (ft3)	(cfs)	(gpm)	
671855	0.2557	115	includes all precip
613303	0.2334	105	includes ET & GW losses
604669	0.2301	103	includes assumed losses

CALCULATED WTP BYPASS

(monthly) (ft3)	(cfs)	(gpm)	
-1084700	-0.4127	-185	includes all precip
-1143252	-0.4350	-196	includes ET & GW losses
-1151886	-0.4383	-197	includes assumed losses





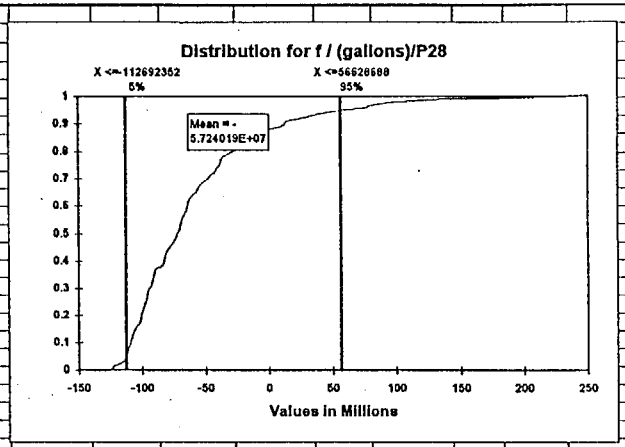


Table 13. Probability of number of years (or less) to dewater Sunday Pit at different WTP flowrates

WTP flowrate	Probability of Number of Years (or Less) to Dewater Sunday Pit		
	90	95	99
200	3.7	>5	>5
250	2.1	>5	>5
300	1.1	2.1	>5
400	0.8	1.3	>5
500	0.7	0.8	3.1
600	0.5	0.6	0.8
700	0.5	0.5	0.7
800	0.4	0.4	0.7

Table 14. Probability of flow bypassing WTP during a year at different WTP flowrates

WTP flowrate	Probability of flow bypassing WTP during a year
200	21%
250	13%
300	8%
400	5%
500	3%
600	<0.5%
700	<0.5%
800	<0.5%

Table 15. Comparison of annual water balances

Water Balance	Precipitation (in)	ET (in)	Infiltration Losses	Runoff (gallons)	Difference (%)
Stochastic	25	15.6	10 gpm	75,869,206	2
WMC, 1999	25	variable	variable	74,189,438	
Stochastic	28.72	15.6	10 gpm	101,018,019	3
Water year 1999	28.72			98,427,821	

Project: Gilt Edge Mine
Job No.: 3280-048
Client: EPA Region 8
Date 3-12-01
Computed by: Steve Fundingsland
Checked by: Mike Smith, 4-17-01
RE: Simple Water Balance

TABLE 16
Water Year 1999 - 2000

Month	WTP Discharge (gal)		Precip-itation (in)	ARD In Storage (gal)		ARD Treated from Storage (gal)	Calc. Runoff, WTP discharge - Treated from Storage (gal)	Stored ARD Treatment Rate (gpm)	Stored ARD Treatement Rate (gal./day)	Stored ARD Treatment Rate (gal./month)
October (1999)	(a) 8,428,032	(a)	0.41 (b)	145,800,000	(c)	6,600,000	1,828,032	148	212,903	6,600,000
November	(a) 8,156,160	(a)	1.75 (b)	139,200,000	(c)	4,700,000	3,456,160	109	156,667	4,700,000
December	(a) 8,780,688	(a)	1.85 (b)	134,500,000	(c)	5,200,000	3,580,688	116	167,742	5,200,000
January (2000)	(a) 9,052,992	(a)	1.23 (b)	129,300,000	(c)	7,100,000	1,952,992	159	229,032	7,100,000
February	(a) 8,681,904	(a)	2.36 (b)	122,200,000	(c)	3,700,000	4,981,904	89	127,586	3,700,000
March	(a) 8,825,328	(a)	2.91 (b)	118,500,000	(c)	-100,000	8,925,328	-2	-3,226	-100,000
April	(a) 8,851,680	(a)	5.42 (b)	118,600,000	(c)	-14,200,000	23,051,680	-329	-473,333	-14,200,000
May	(a) 9,642,240	(a)	4.16 (b)	132,800,000	(c)	-15,700,000	25,342,240	-352	-506,452	-15,700,000
June	(a) 9,473,760	(a)	3.93 (b)	148,500,000	(c)	500,000	8,973,760	12	16,667	500,000
July	(a) 9,427,968	(a)	2.38 (b)	148,000,000	(c)	3,100,000	6,327,968	69	100,000	3,100,000
August	(a) 9,262,800	(a)	0.73 (b)	144,900,000	(c)	8,400,000	862,800	188	270,968	8,400,000
September	(a) 8,635,680	(a)	1.59 (b)	136,500,000	(c)	-508,619	9,144,299	-12	-16,954	
Total	107,219,232		28.72	137,008,619	(d)	8,791,381	98,427,851	16	27,141	845,455

Notes:
(1) No losses calculated
(2) Turbo Mister operating in 1999
WTP = water treatment plant

(a) FHI reports, average treatment rate for month

Month	Days	Minutes	Treatment Rate (gpm)		Total for Month (gal)
October (1999)	31	44,640.0	188.8	FHI	8,428,032
November	30	43,200.0	196.7	FHI	8,156,160
December	31	44,640.0	202.8	FHI	8,780,688
January (2000)	31	44,640.0	207.9	FHI	9,052,992
February	29	41,760.0	197.7	FHI	8,681,904
March	31	44,640.0	204.9	FHI	8,825,328
April	30	43,200.0	216.0	FHI	8,851,680
May	31	44,640.0	219.3	FHI	9,642,240
June	30	43,200.0	211.2	FHI	9,473,760
July	31	44,640.0	207.5	FHI	9,427,968
August	31	44,640.0	199.9	FHI	9,262,800
September	30	43,200.0	201.1	FHI	8,635,680
		527,040.0	204.5		107,219,232

(b) Homestake Mine Precip. provided by SD DENR

Month	NOAA - Lead (in)
October (1999)	0.41
November	1.75
December	1.85
January (2000)	1.23
February	2.36
March	2.91
April	5.42
May	4.16
June	3.93
July	2.38
August	0.73
September	1.59
Total	28.72

(c) Stored ARD provided by SD DENR

Month	Gallons
October (1999)	145,800,000
November	139,200,000
December	134,500,000
January (2000)	129,300,000
February	122,200,000
March	118,500,000
April	118,600,000
May	132,800,000
June	148,500,000
July	148,000,000
August	144,900,000
September	136,500,000
October	137,000,000

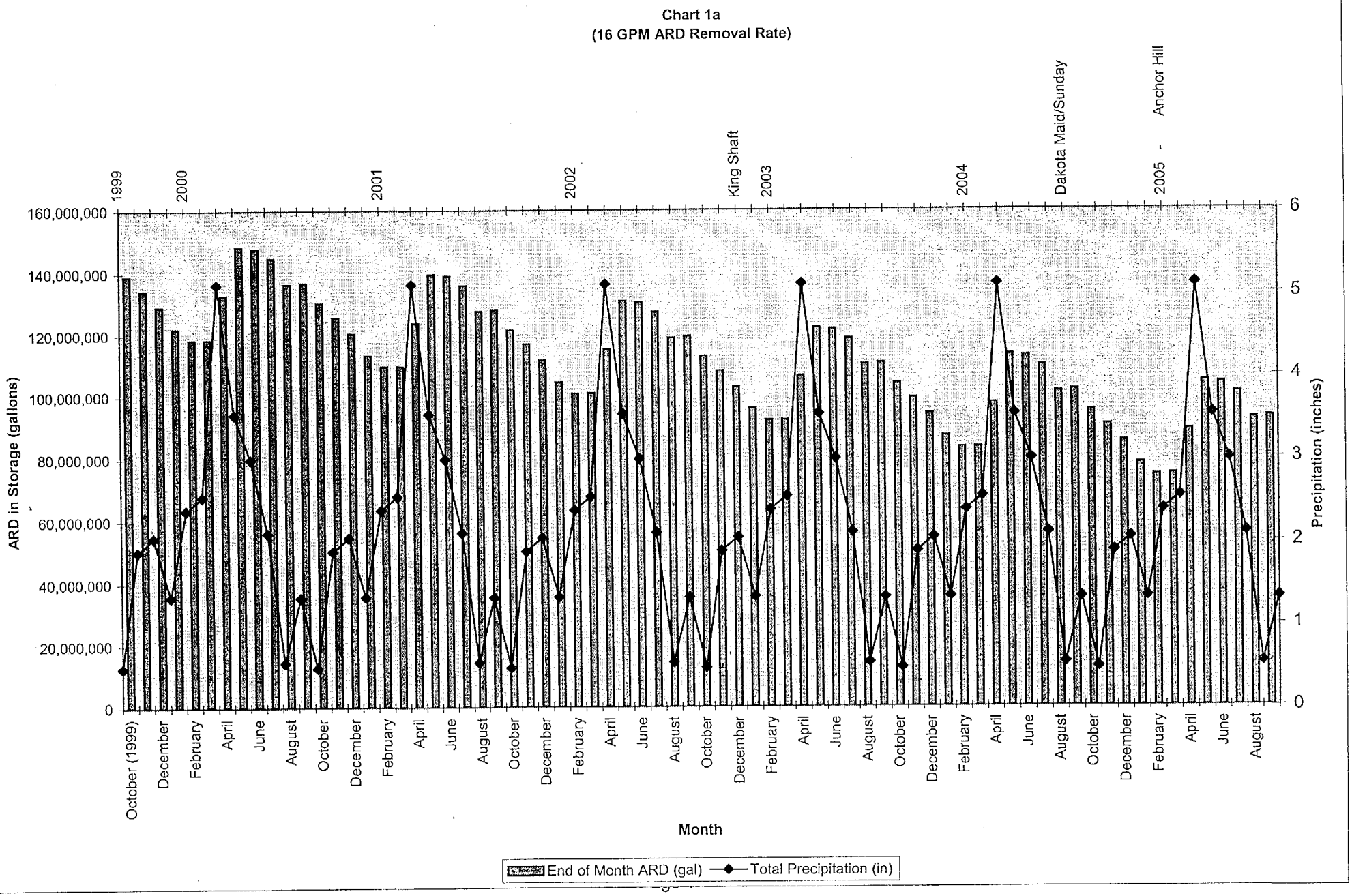
(d) FHI Monthly Reports (end of month)

Stored ARD	September
Dakota Maid	0
Sunday	70,664,878
Anchor Hill	54,503,441
Storm Water	11,840,300
Total Stored	137,008,619

(g) Underground Working pump from Dakota Maid Shaft to Sunday Pit

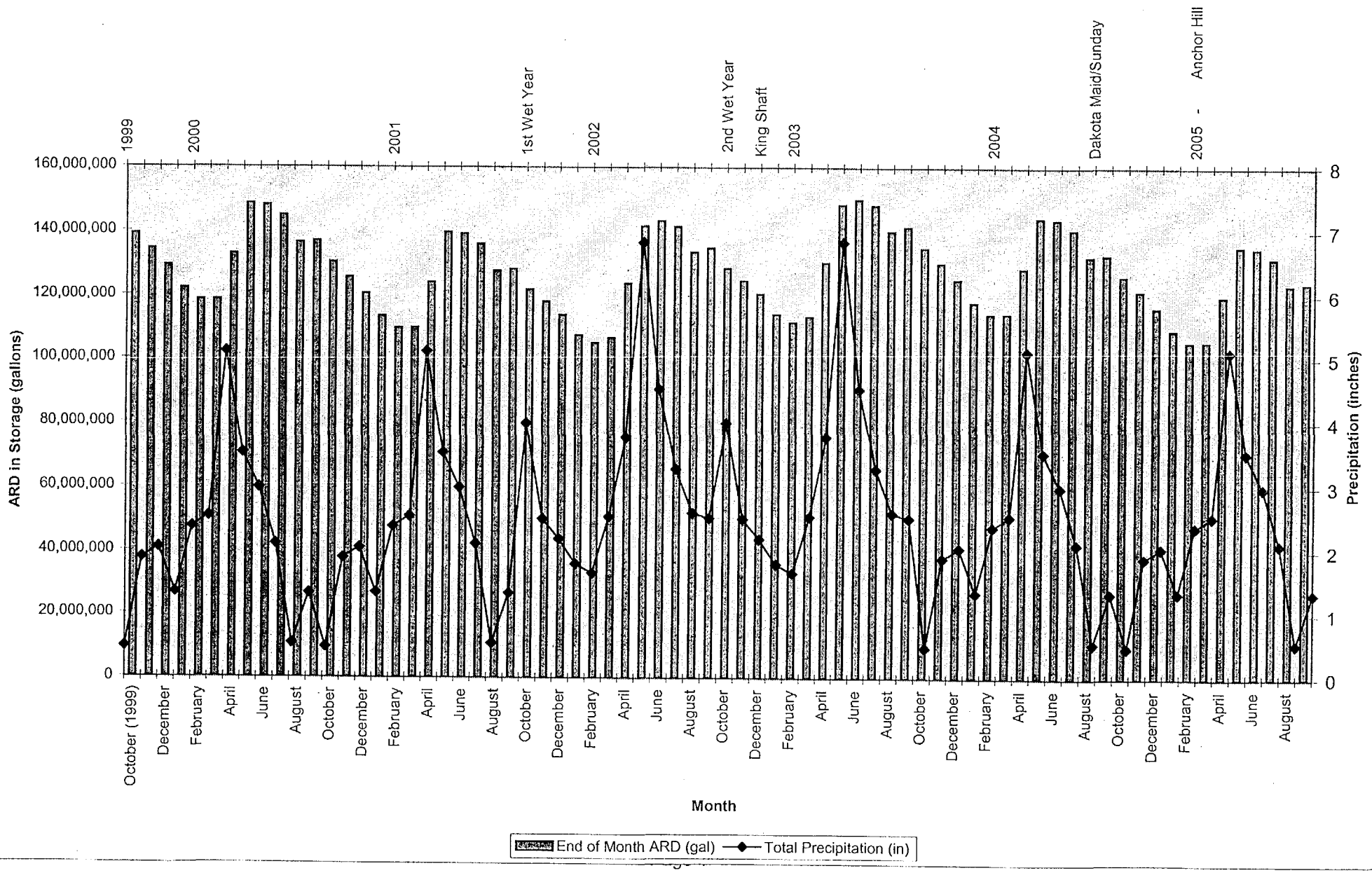
Month	gal	gpm (for 1 yr)	Prec. Equiv (in)
August	5,890,000	11	0.07
September	4,004,000	8	0.05
Total	9,894,000	9	0.06

200 GPM Treatment Rate (Treat All ARD Waters)
(Current Operations, No Changes
(No Ruby Flow Reduction)

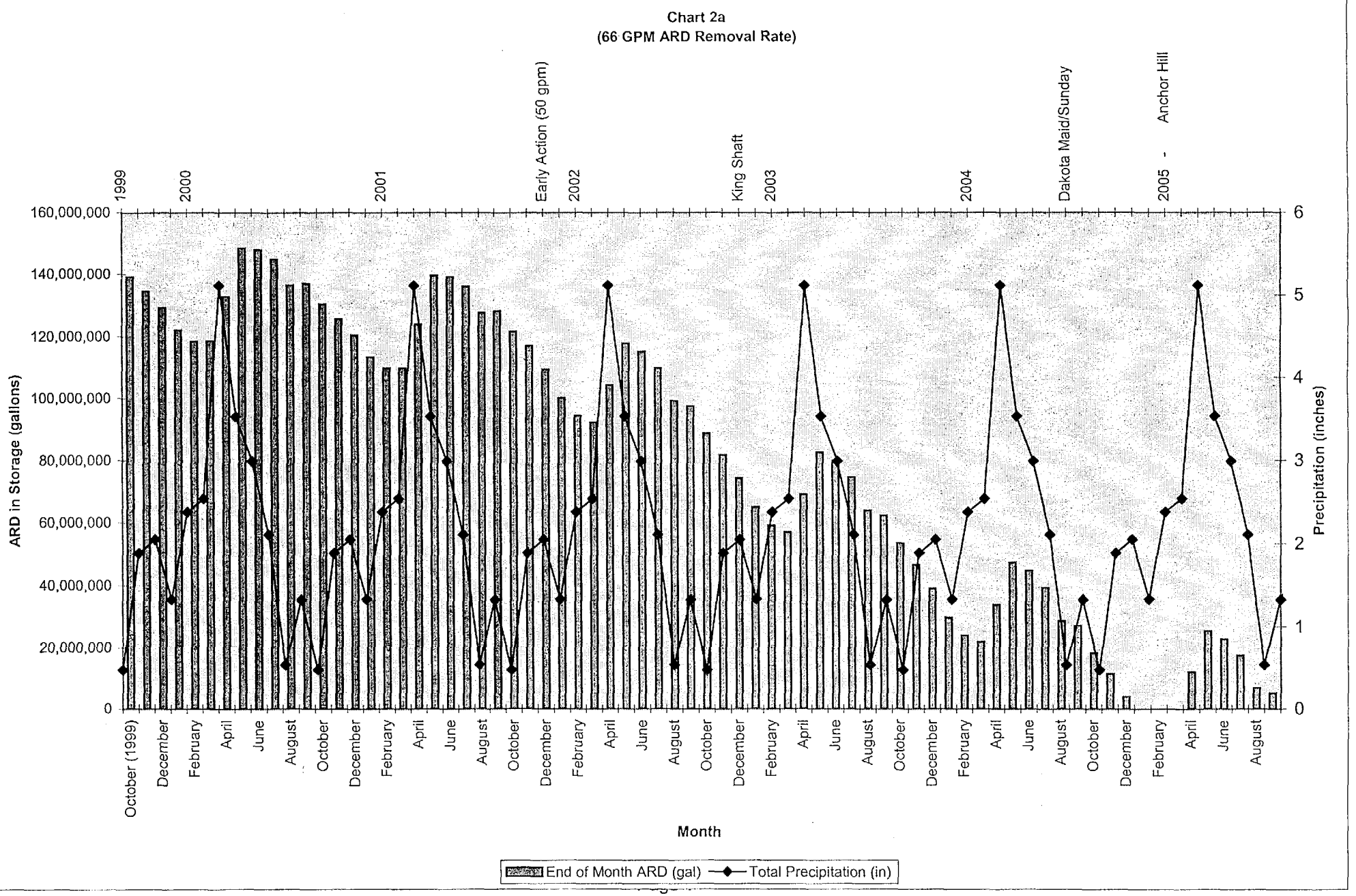


200 GPM Treatment Rate (Treat All ARD Waters) with Two Wet Years
(Current Operations, No Change)
(No Ruby Flow Reduction)

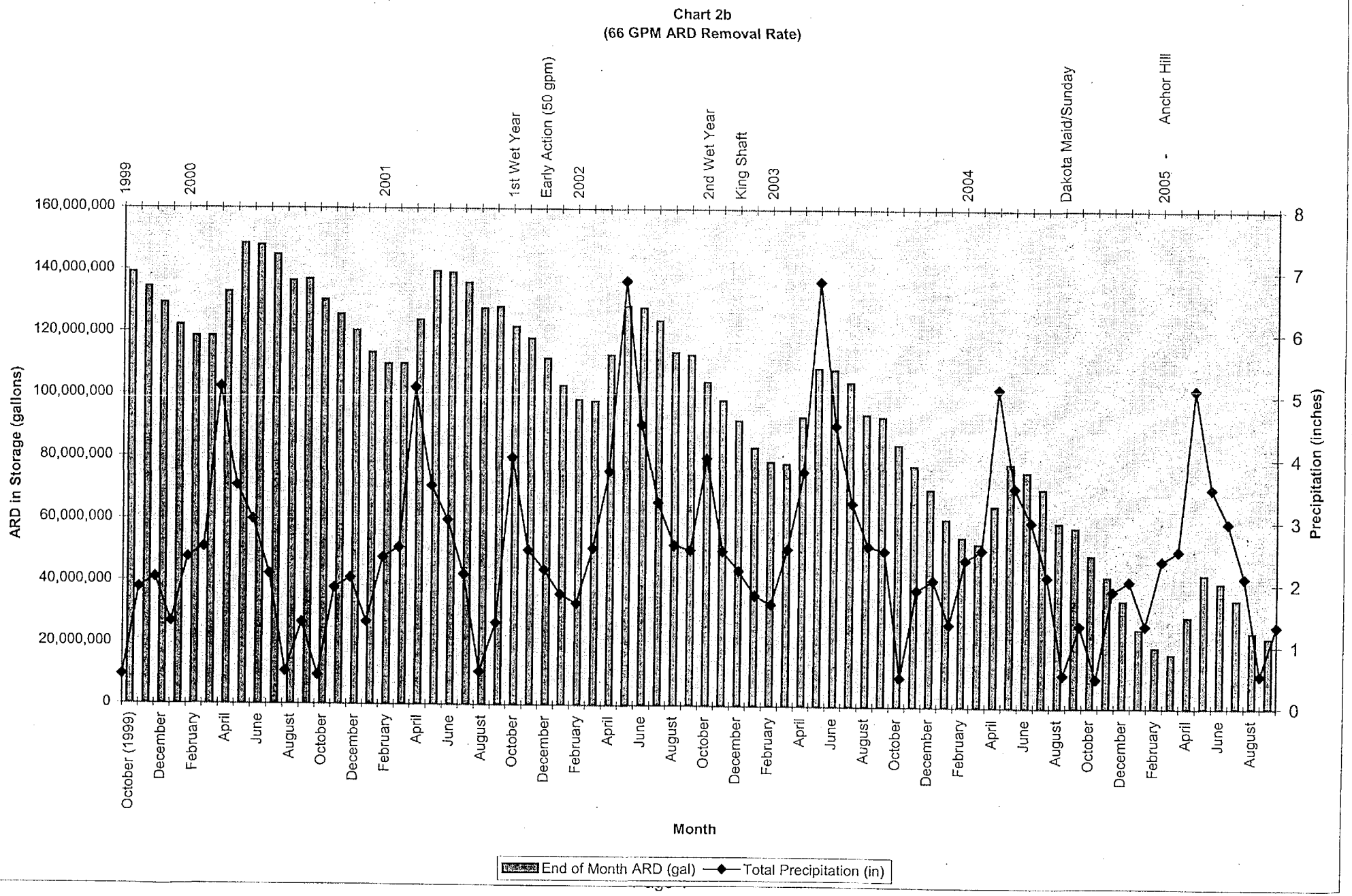
Chart 1b
(16 GPM ARD Removal Rate)



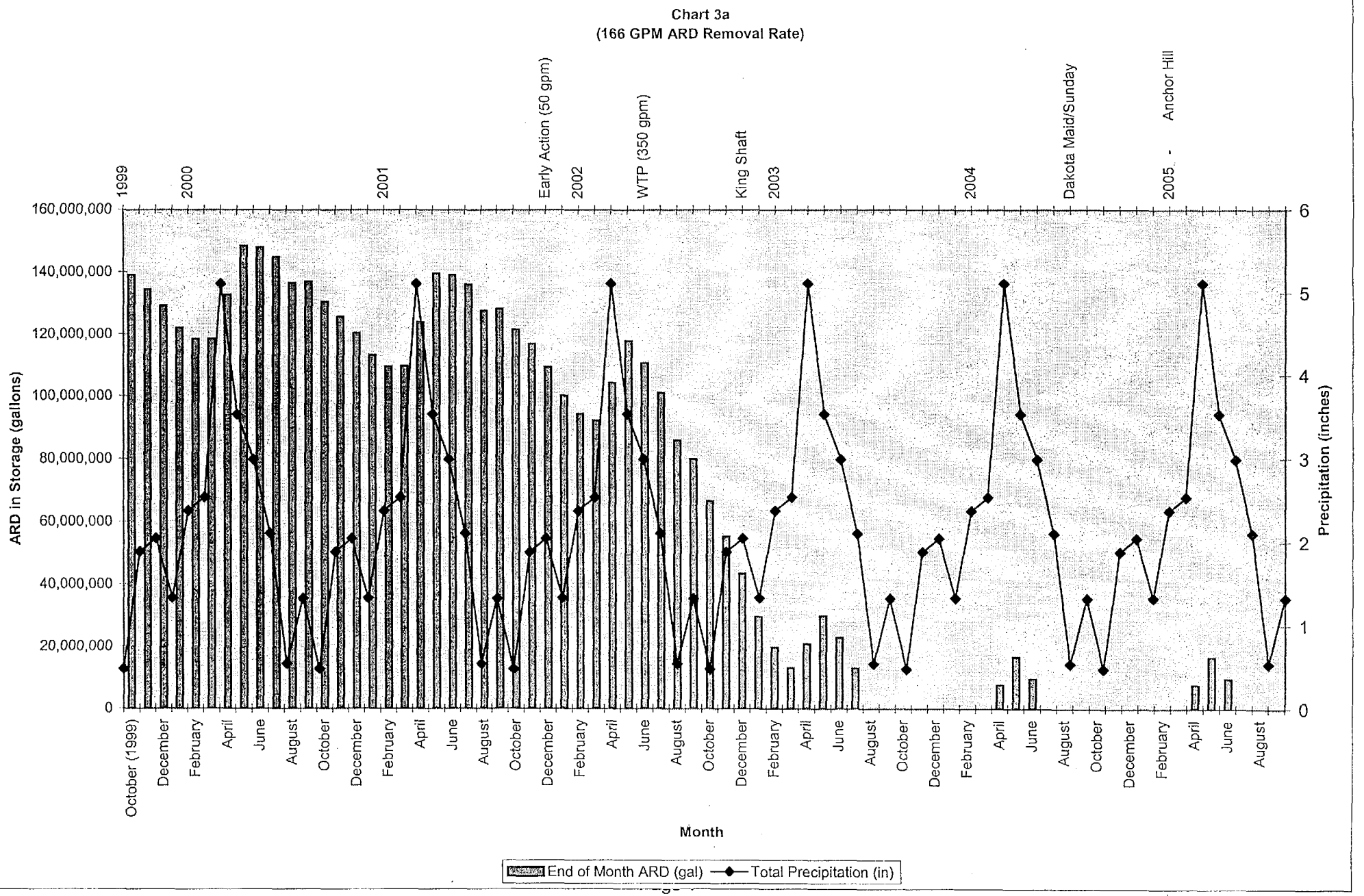
250 GPM Net-Treatment Rate (Treat All ARD Waters)
(Current Operations + Filter Press
(No Ruby Flow Reduction)



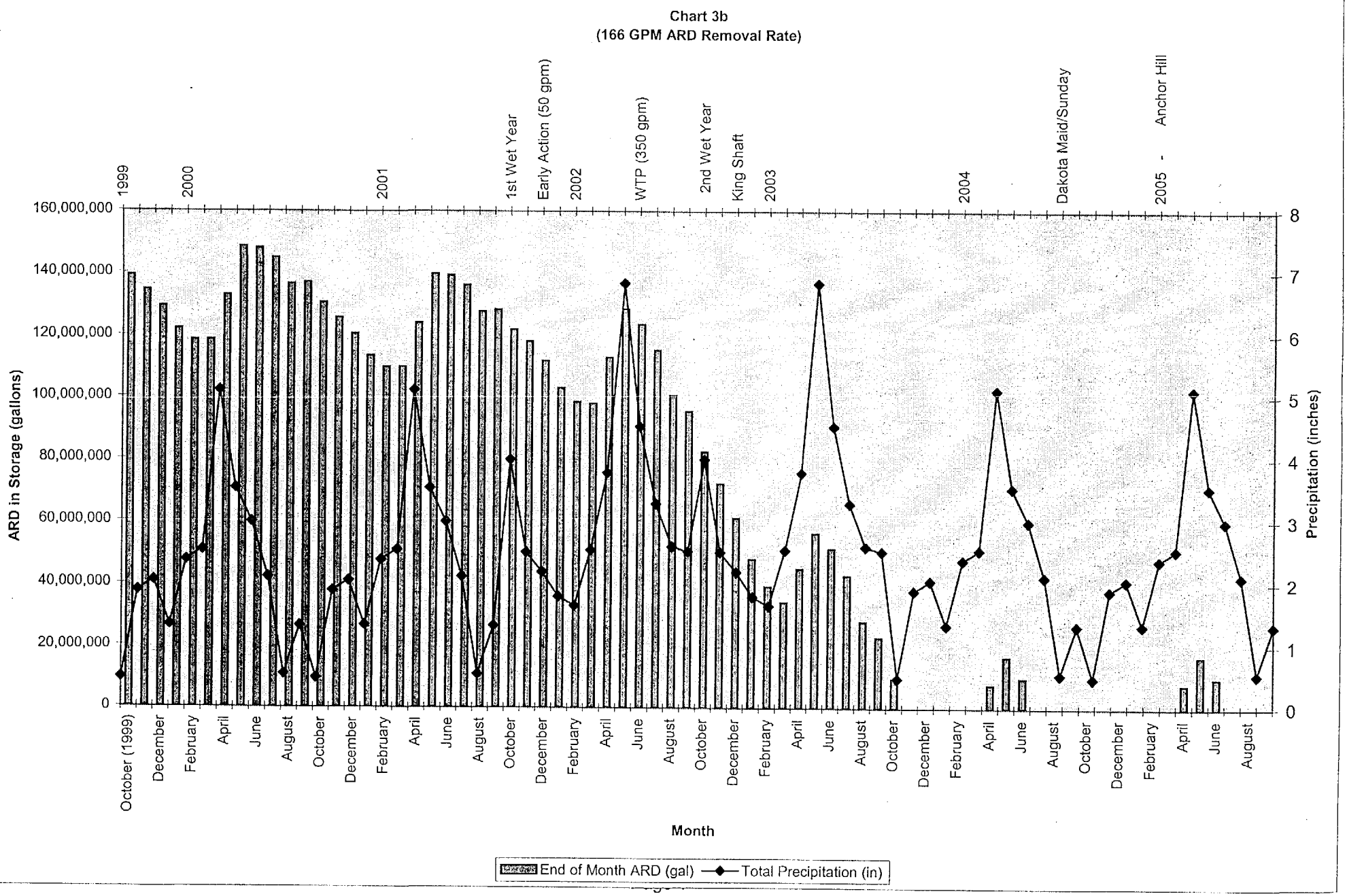
250 GPM Net-Treatment Rate (Treat All ARD Waters) with Two Wet Years
(Current Operations + Filter Press)
(No Ruby Flow Reduction)



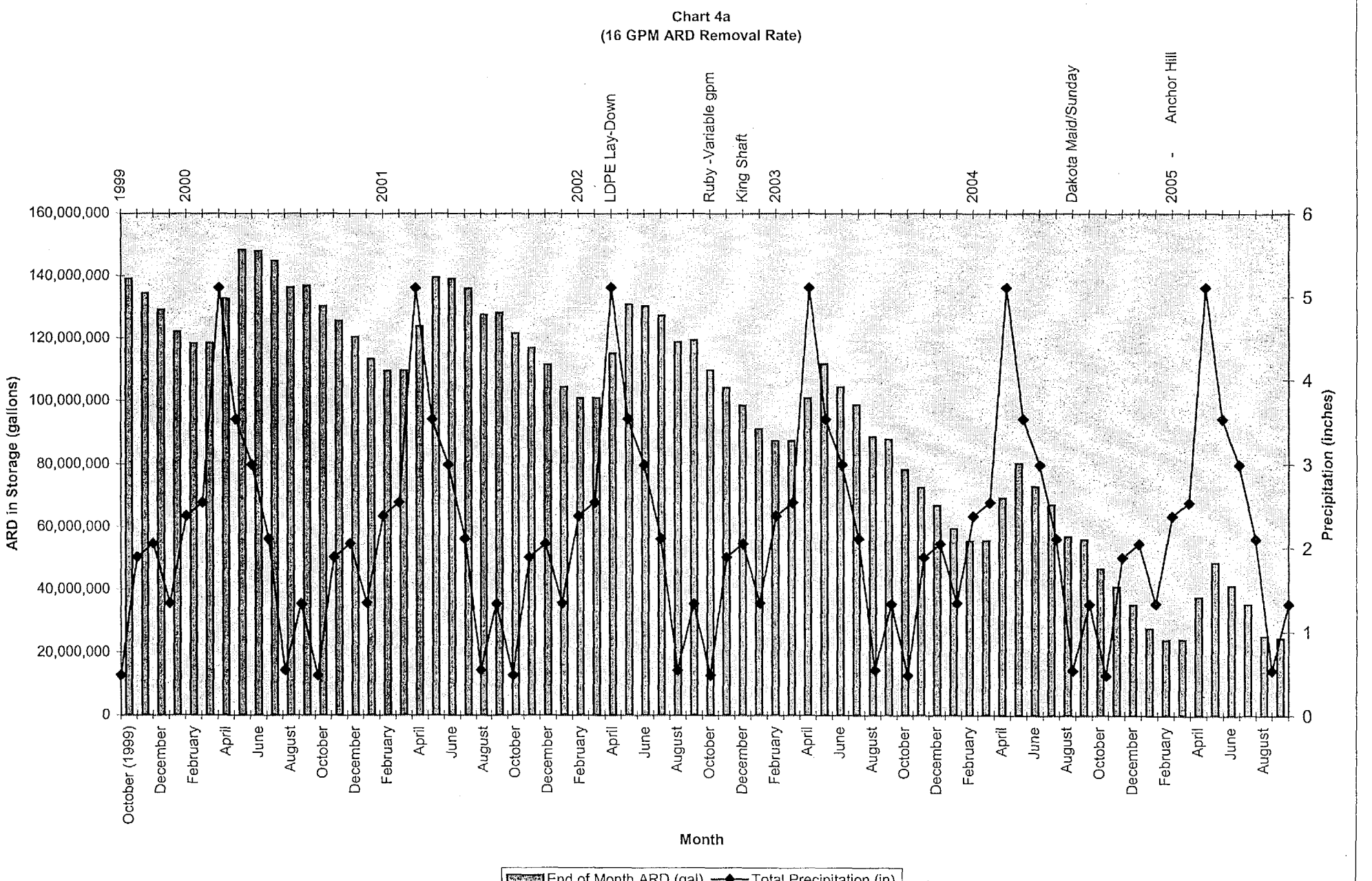
350 GPM Net-Treatment Rate (Treat All ARD Waters)
(Current Operations + Filter Press + 100 GPM Plant)
(No Ruby Flow Reduction)



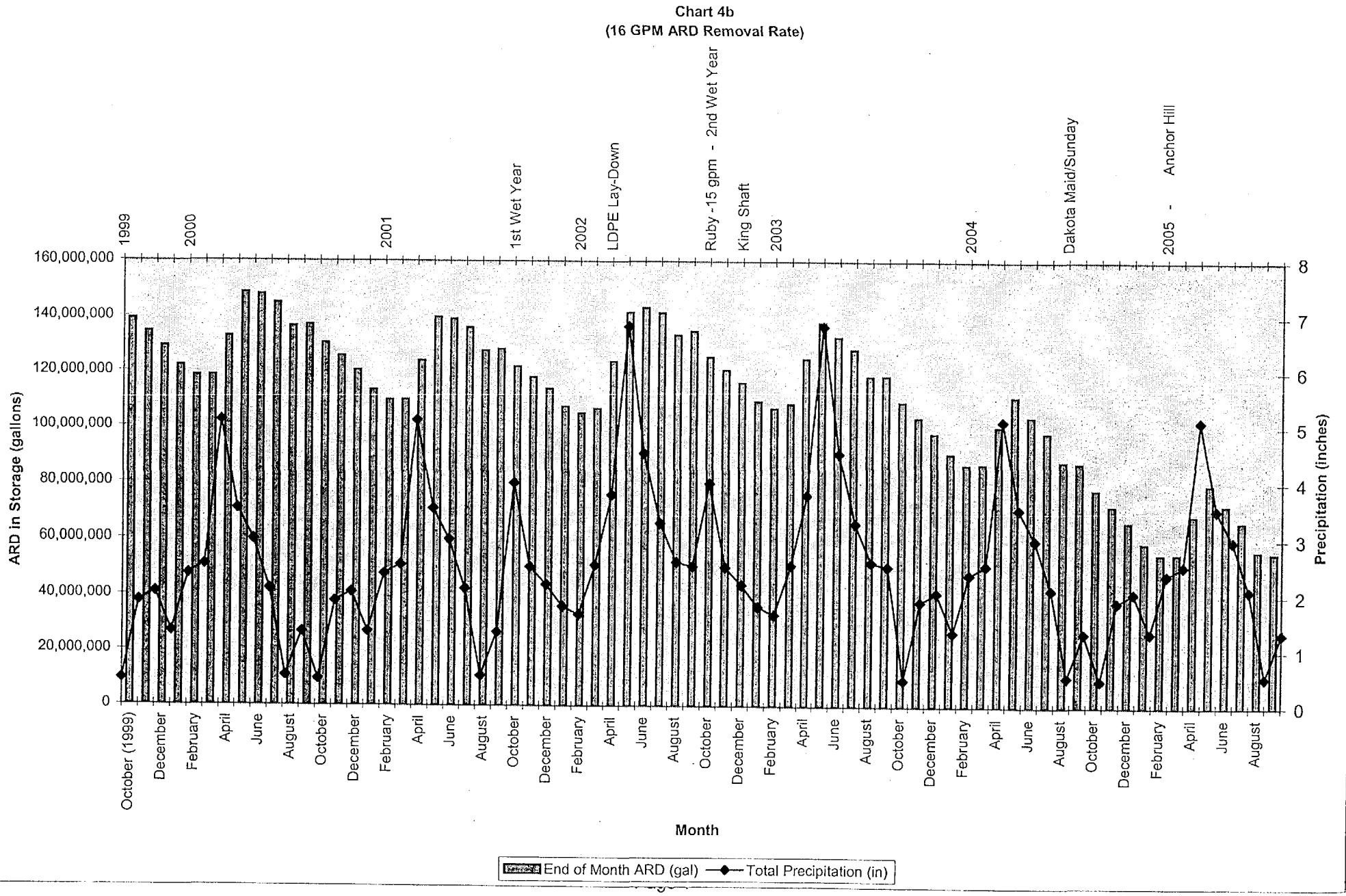
350 GPM Net-Treatment Rate (Treat All ARD Waters) with Two Wet Years
(Current Operations + Filter Press + 100 GPM Plant)
(No Ruby Flow Reduction)



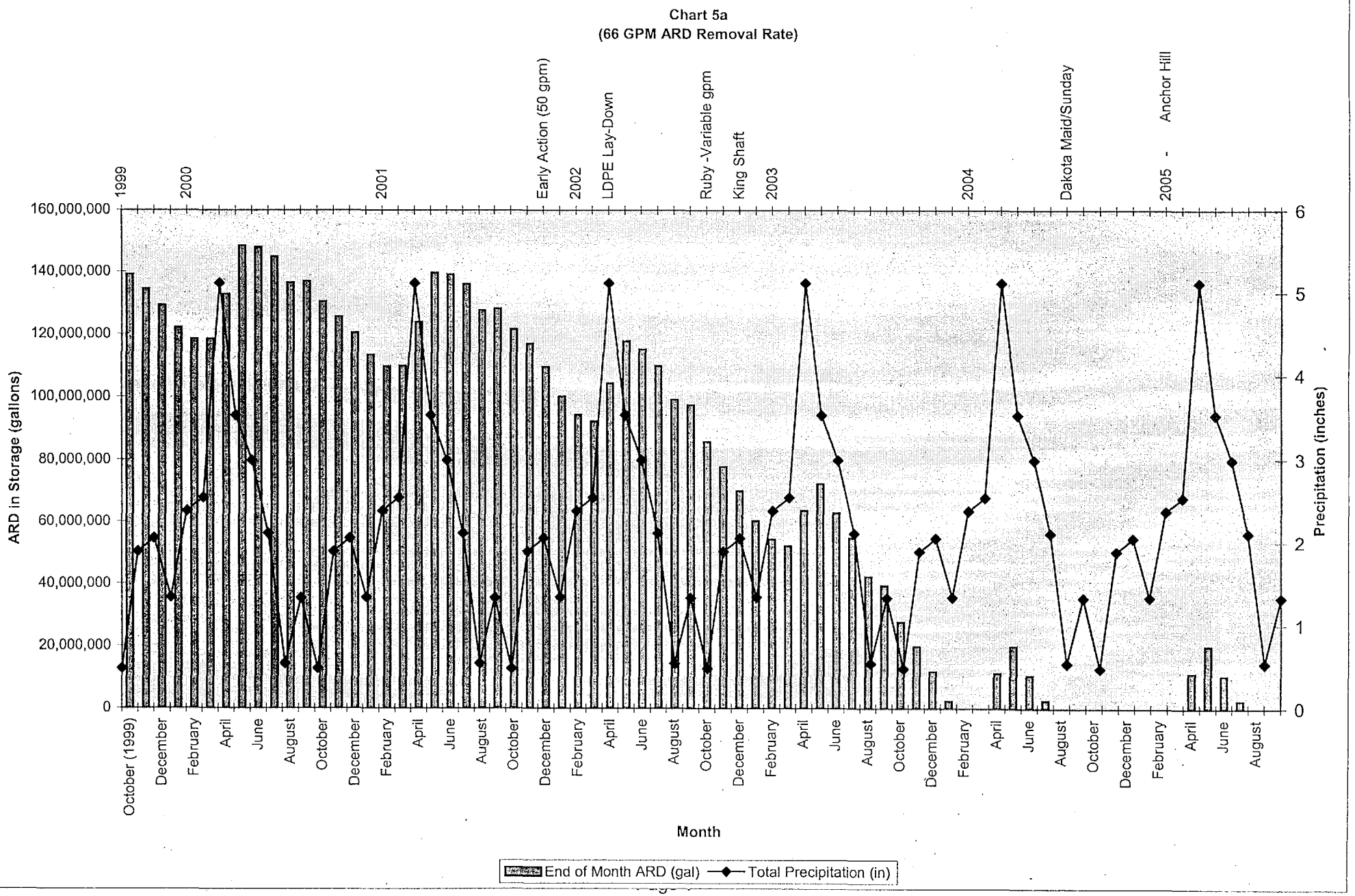
200 GPM Treatment Rate (Treat All ARD Waters)
(Current Operations, No Changes)
(Ruby @ 15 GPM Residual Flow)



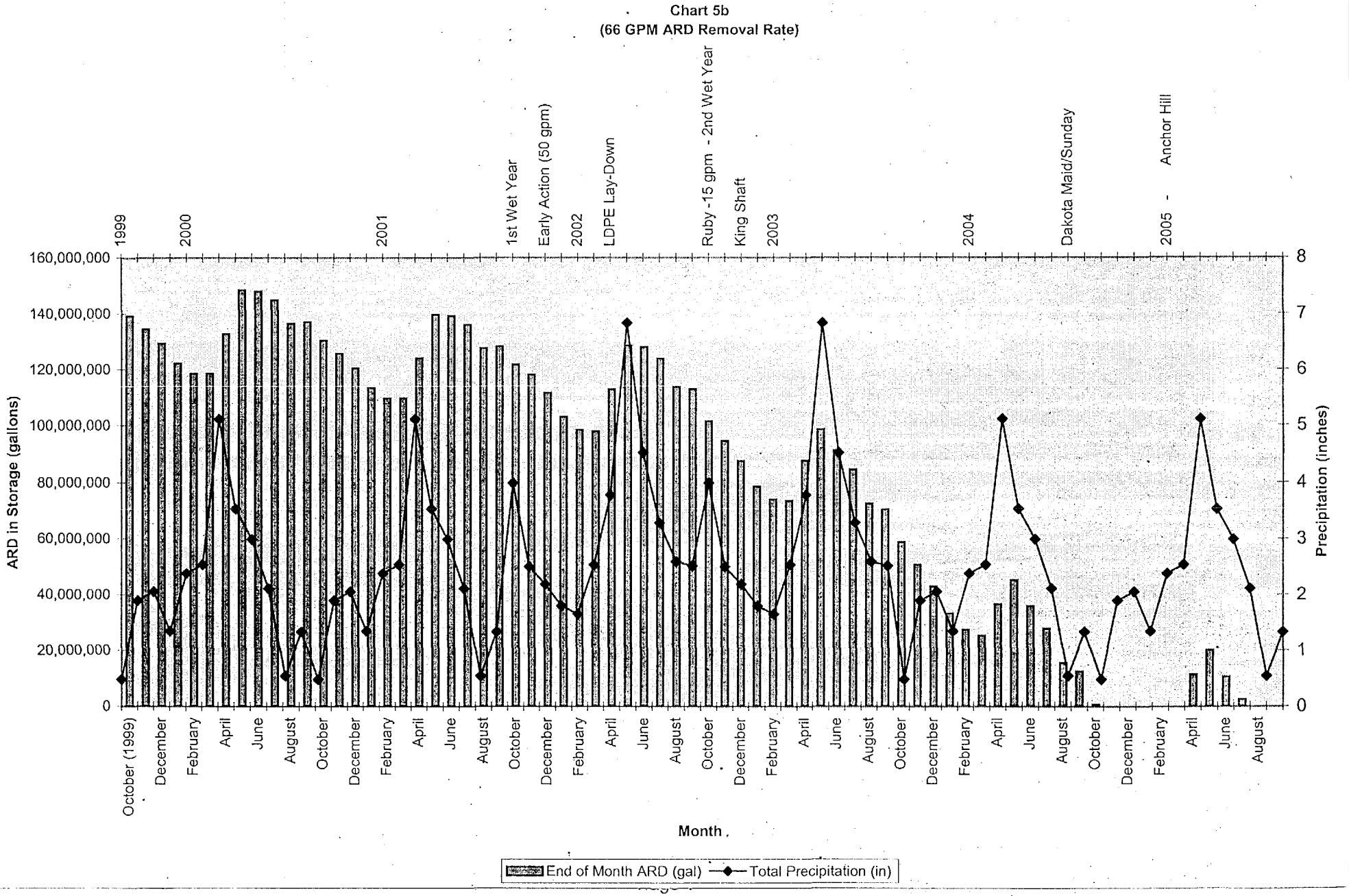
200 GPM Net-Treatment Rate (Treat All ARD Waters) with Two Wet Years
(Current Operations, No Changes)
(Ruby @ 15 GPM Residual Flow)



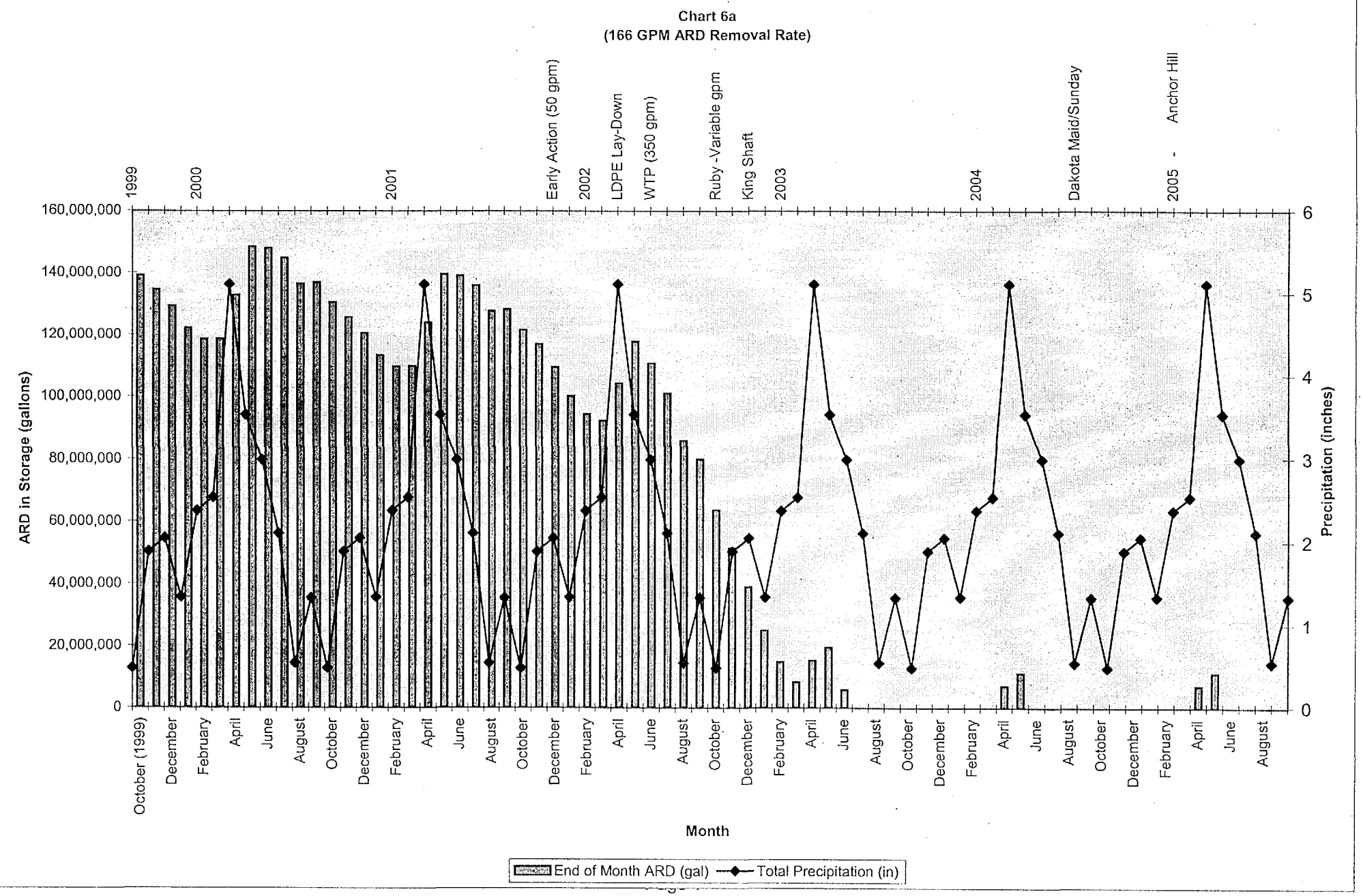
250 GPM Net-Treatment Rate (Treat All ARD Waters)
(Current Operations + Filter Press)
(Ruby @ 15 GPM Residual Flow)



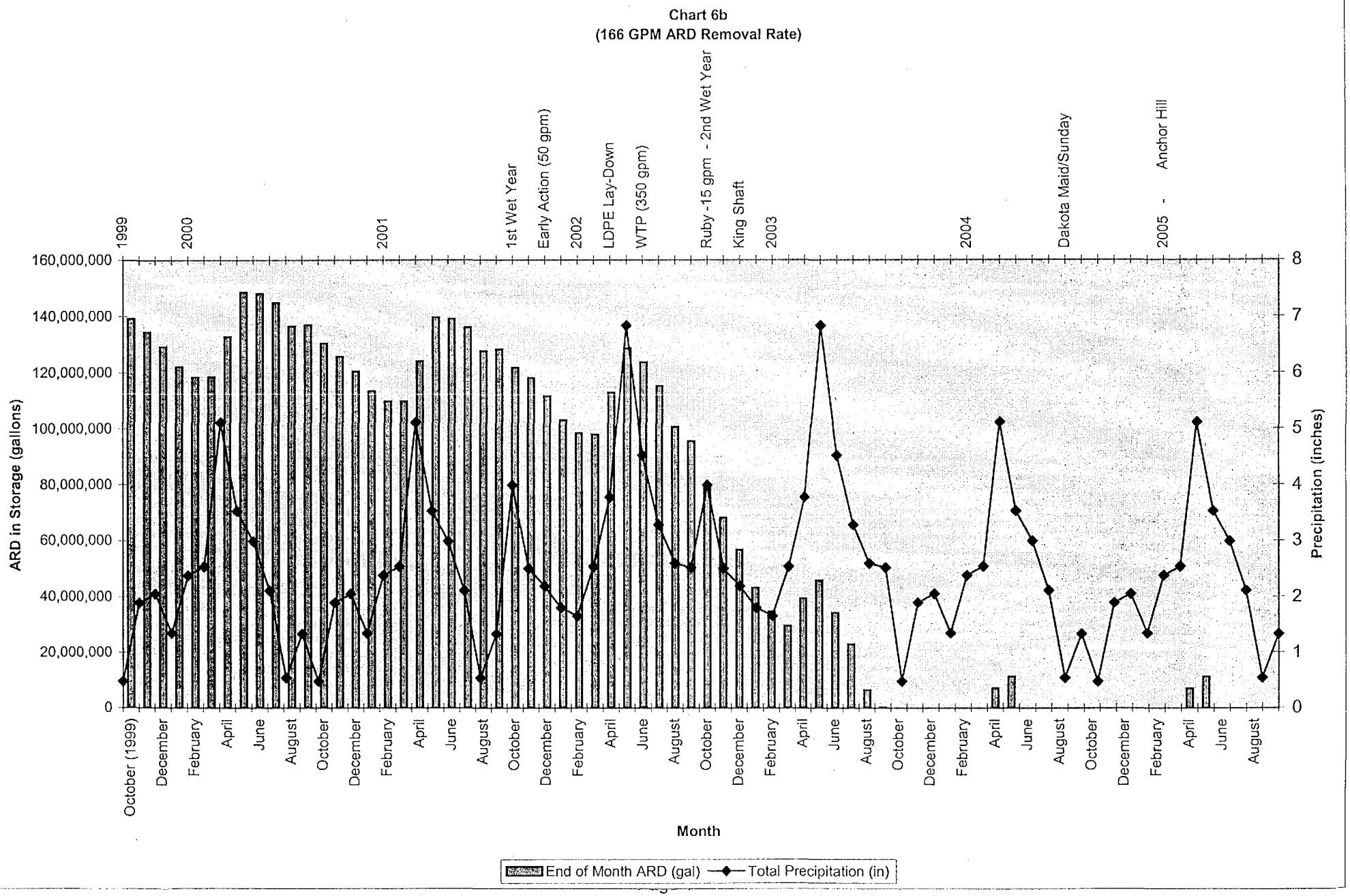
250 GPM Net-Treatment Rate (Treat All ARD Waters) with Two Wet Years
(Current Operations + Filter Press)
(Ruby @ 15 GPM Residual Flow)



350 GPM Net-Treatment Rate (Treat All ARD Waters)
(Current Operations + Filter Press + 100 GPM Plant)
(Ruby @ 15 GPM Residual Flow)

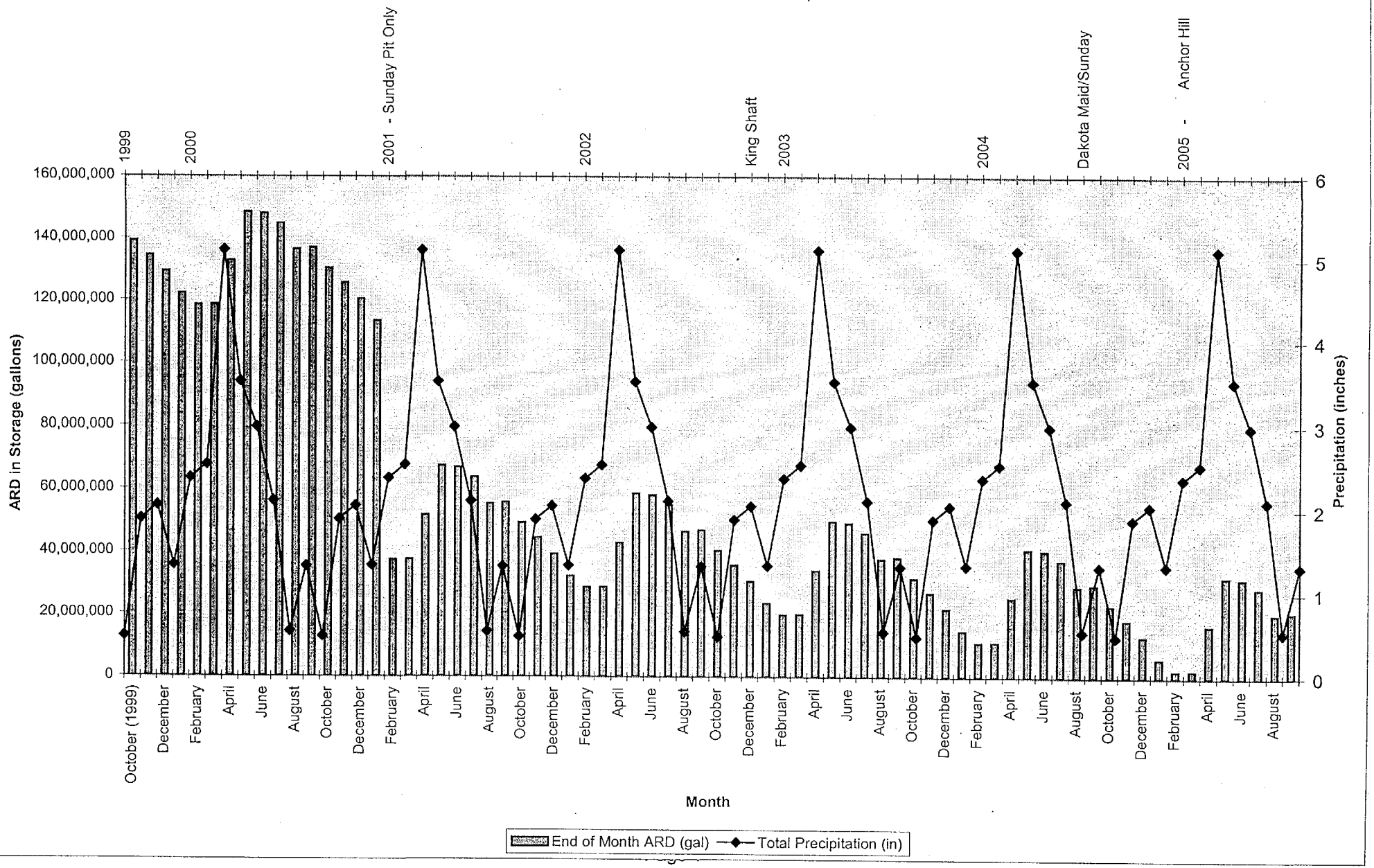


350 GPM Net-Treatment Rate (Treat All ARD Waters) with Two Wet Years
(Current Operations + Filter Press + 100 GPM Plant)
(Ruby @ 15 GPM Residual Flow)

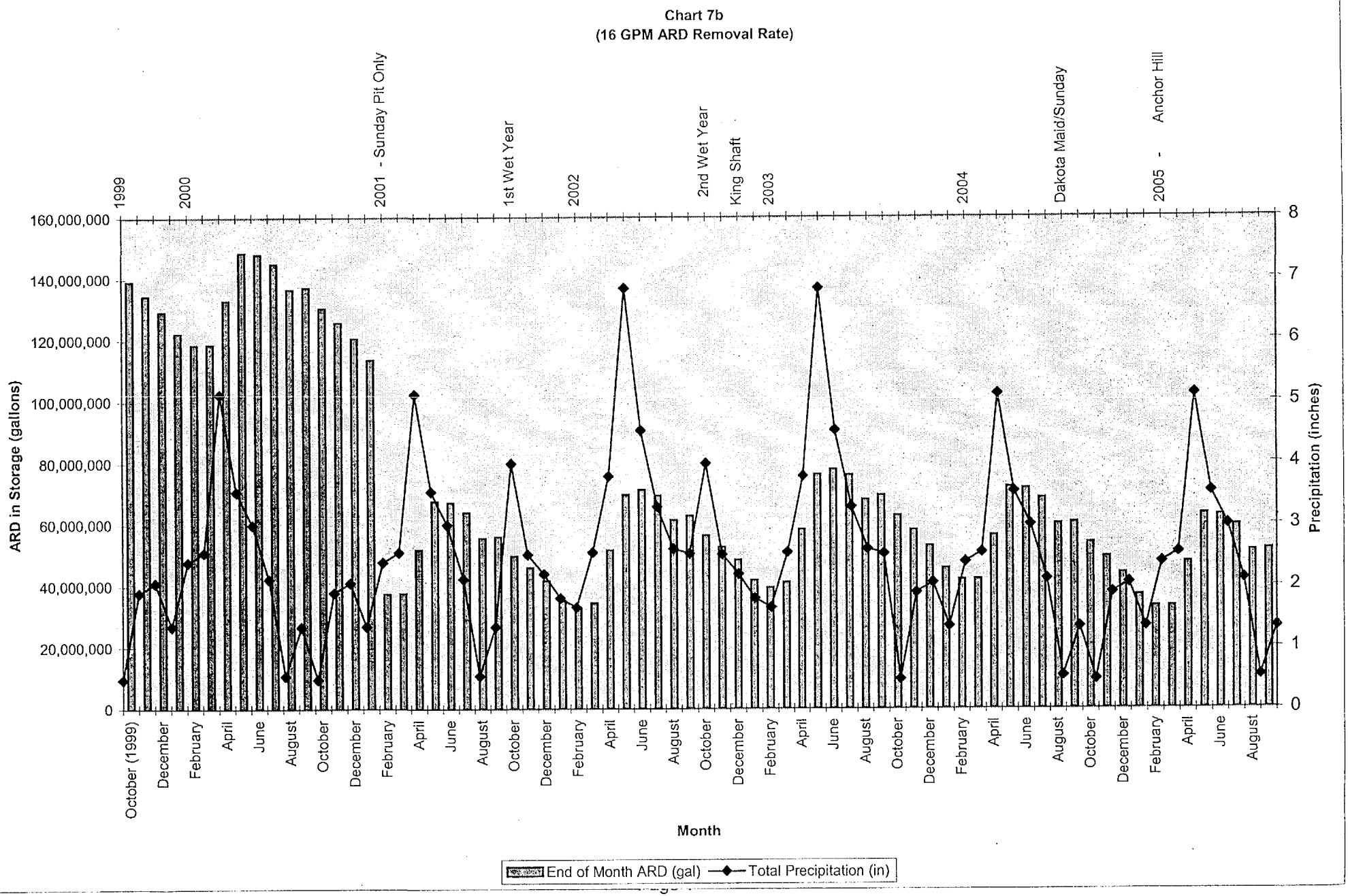


200 GPM Treatment Rate (Treat Sunday Pit ARD Water)
(Current Operations, No Changes)
(No Ruby Flow Reduction)

Chart 7a
(16 GPM ARD Removal Rate)

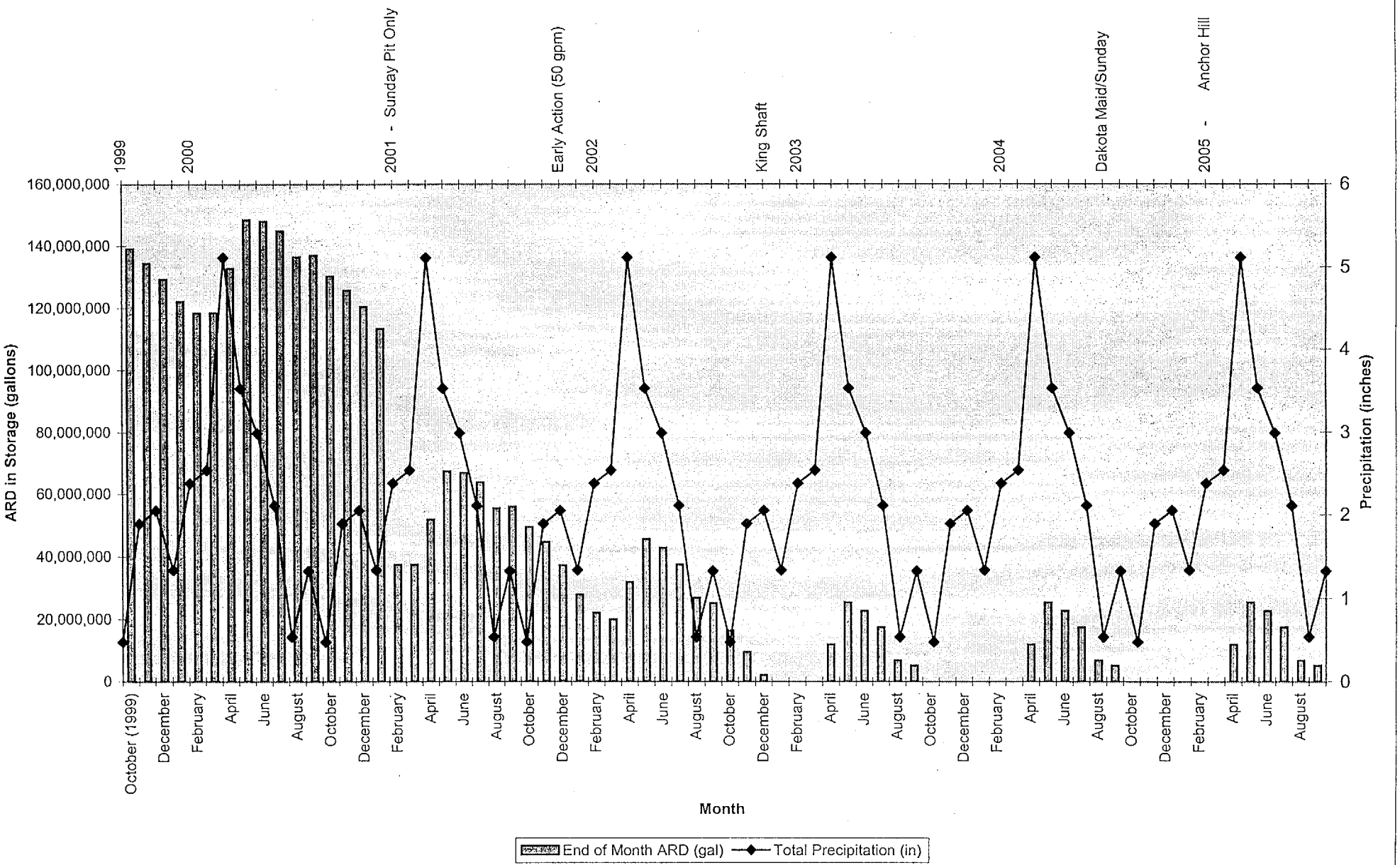


200 GPM Treatment Rate (Treat Sunday Pit ARD Water) with Two Wet Years
(Current Operations, No Changes)
(No Ruby Flow Reduction)

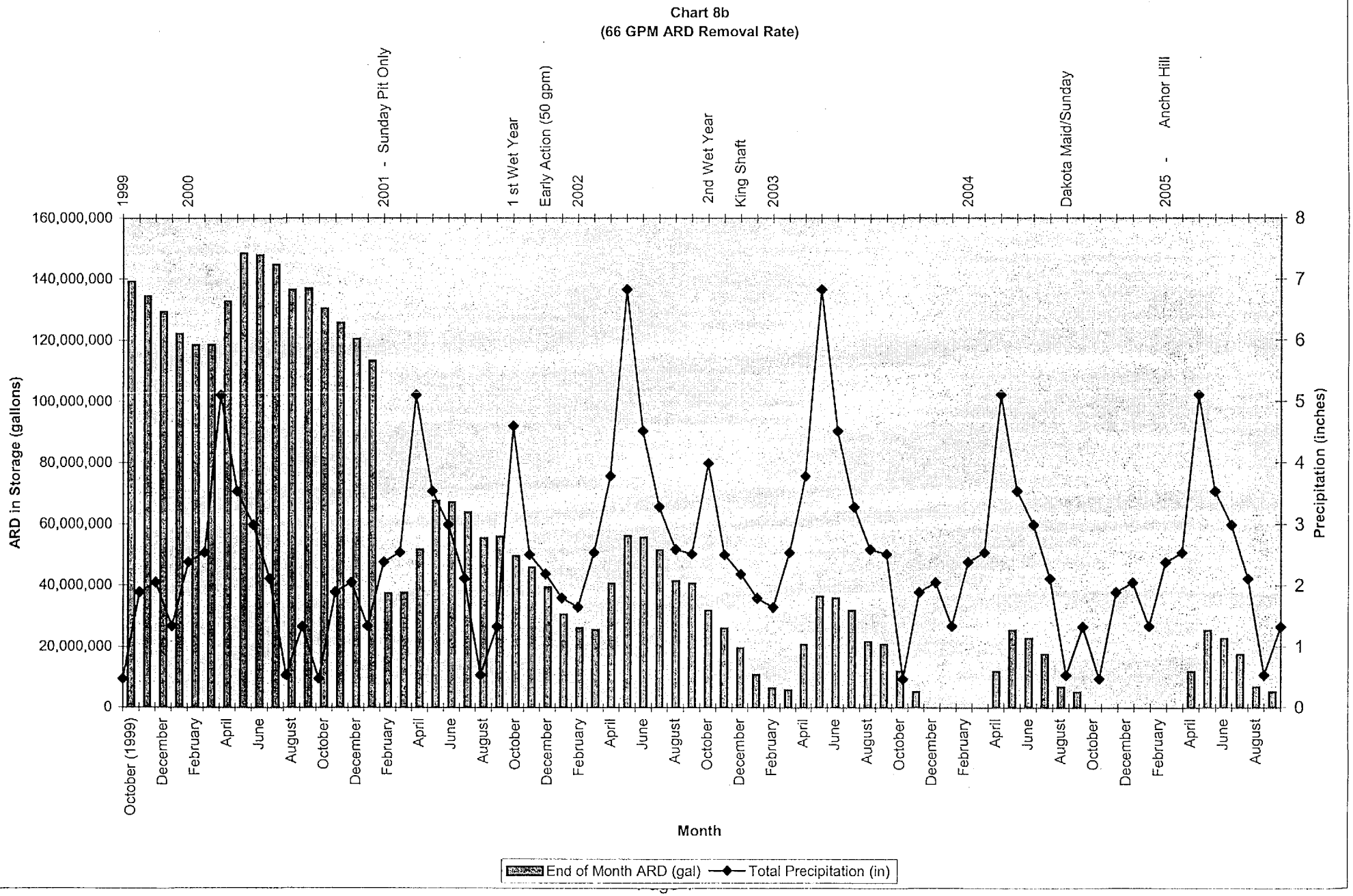


250 GPM Net-Treatment Rate (Treat Sunday Pit ARD Water)
(Current Operations + Filter Press)
(No Ruby Flow Reduction)

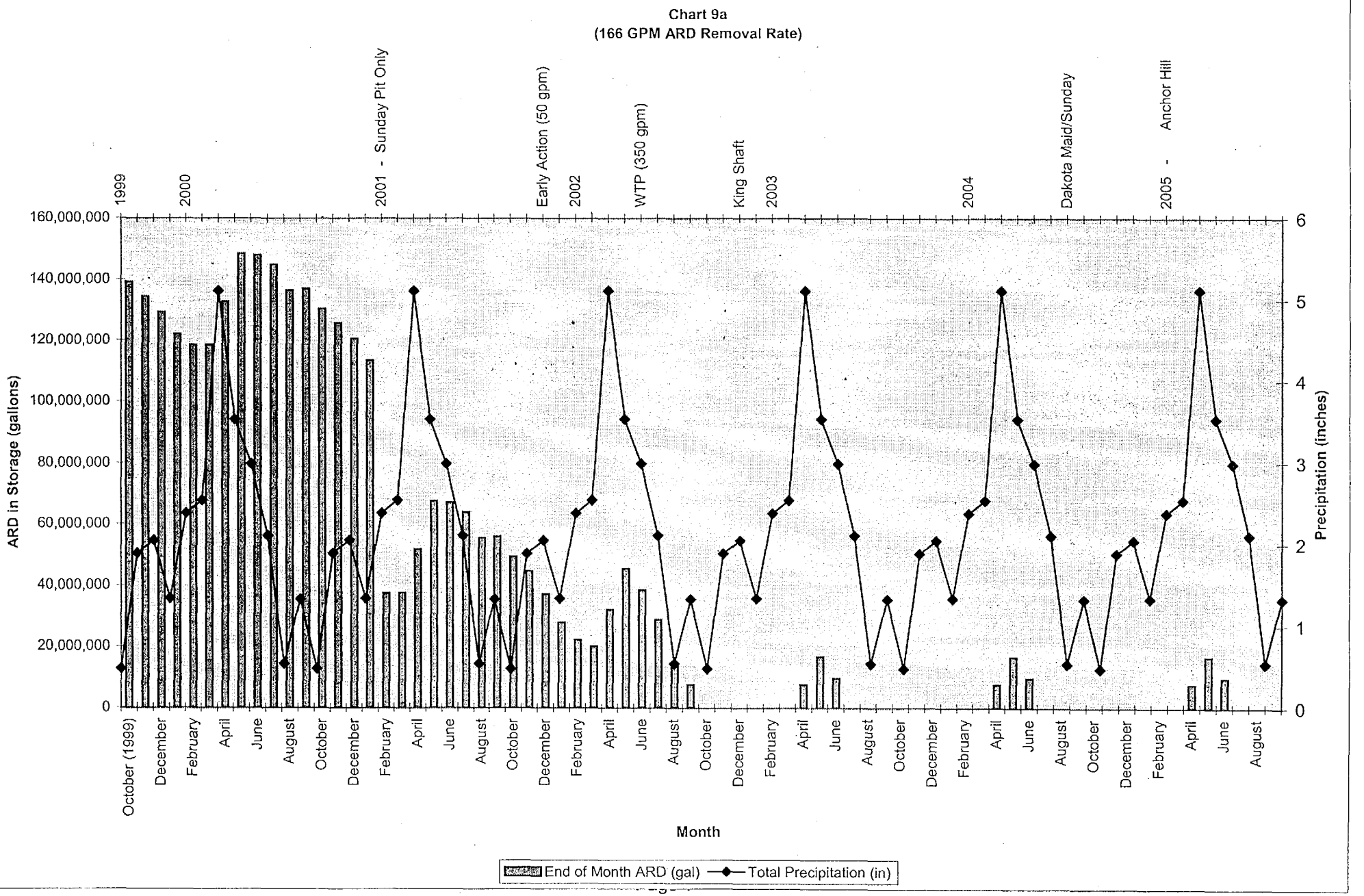
Chart 8a
(66 GPM ARD Removal Rate)



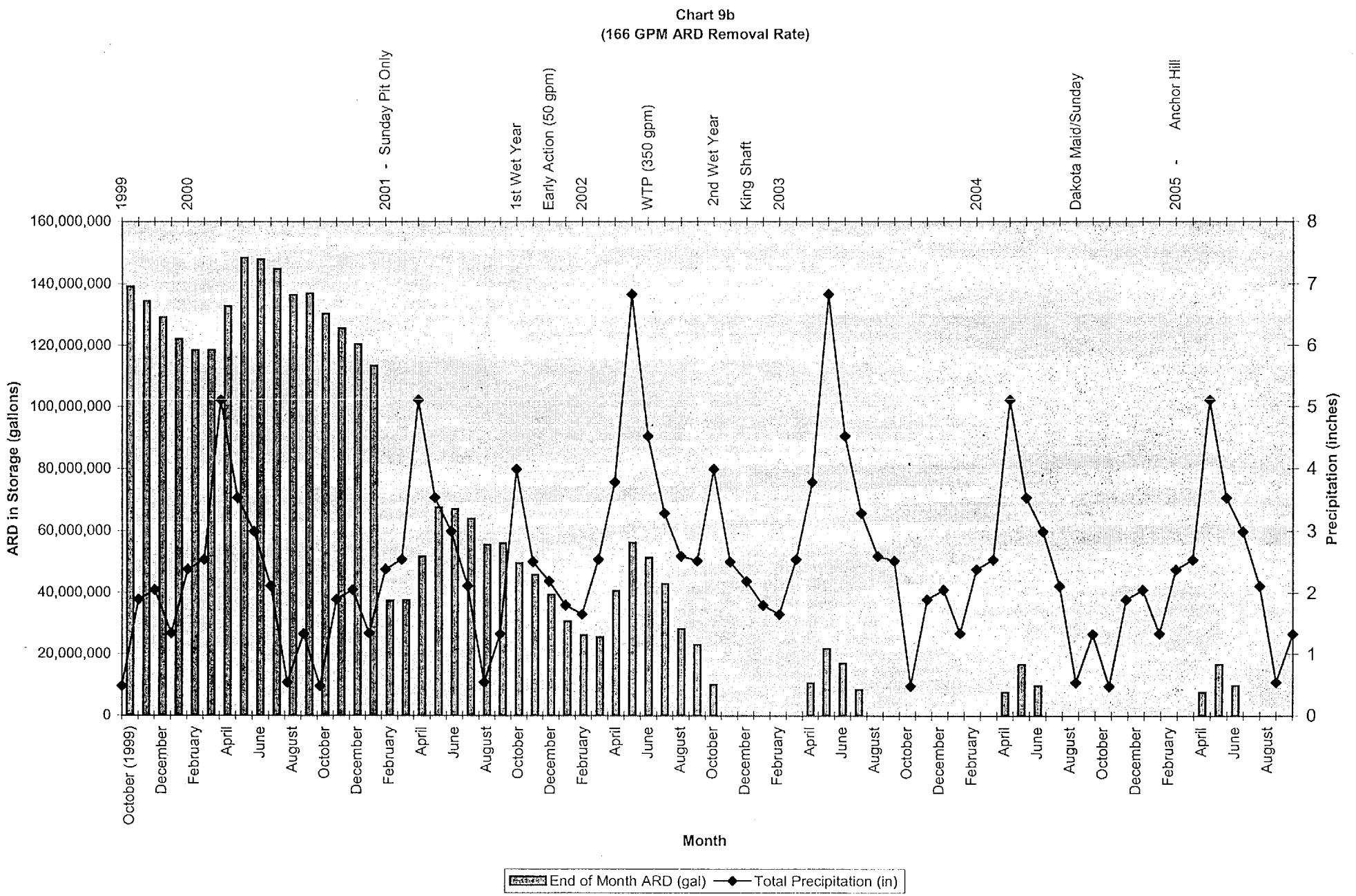
250 GPM Net-Treatment Rate (Treat Sunday Pit ARD Water) With 2 Wet Years
(Current Operations + Filter Press)
(No Ruby Flow Reduction)



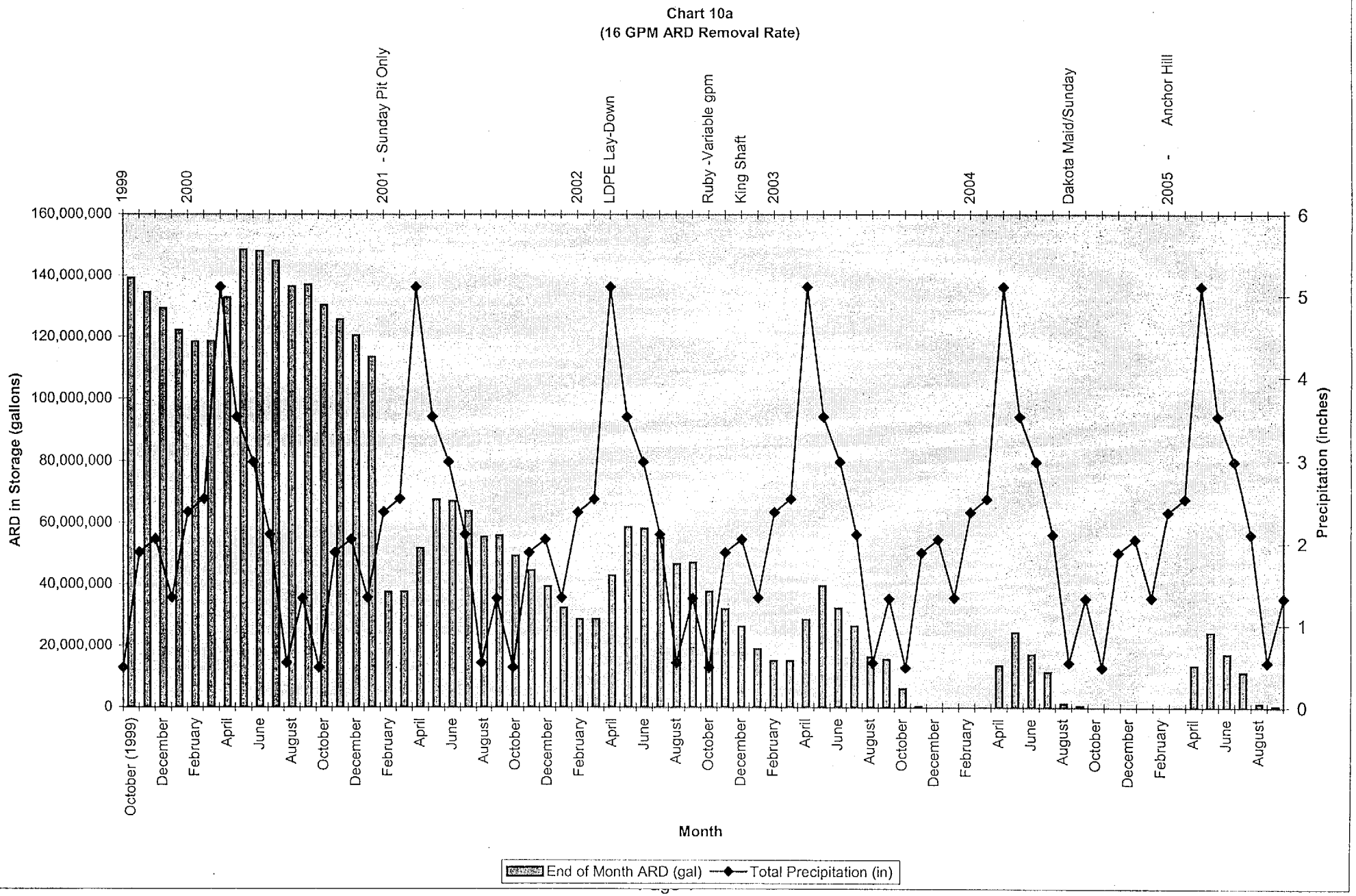
350 GPM Net-Treatment Rate (Treat Sunday Pit ARD Water)
(Current Operations + Filter Press + 100 GPM Plant)
(No Ruby Flow Reduction)



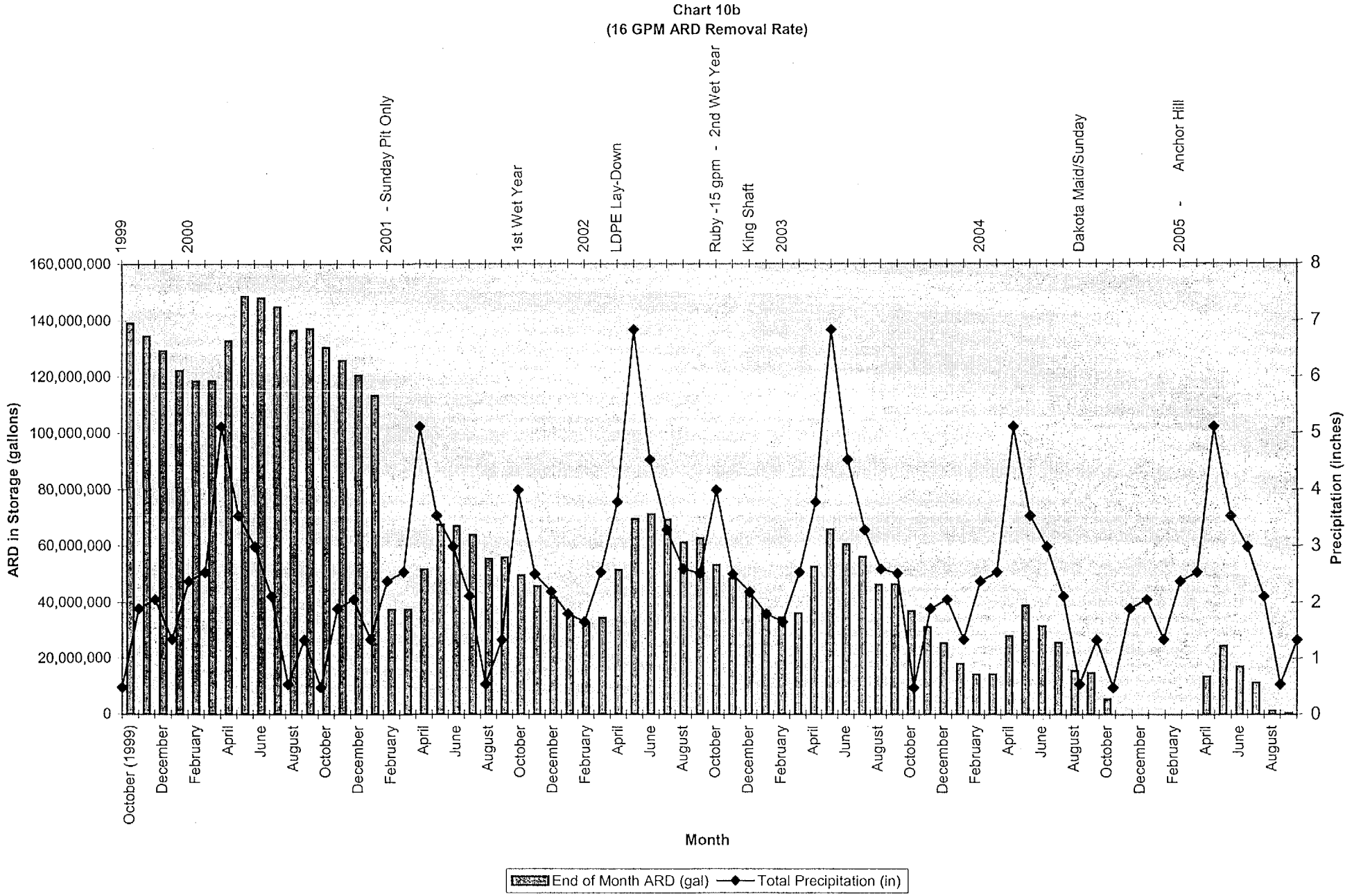
350 GPM Net-Treatment Rate (Treat Sunday Pit ARD Water) with Two Wet Years
(Current Operations + Filter Press + 100 GPM Plant)
(No Ruby Flow Reduction)



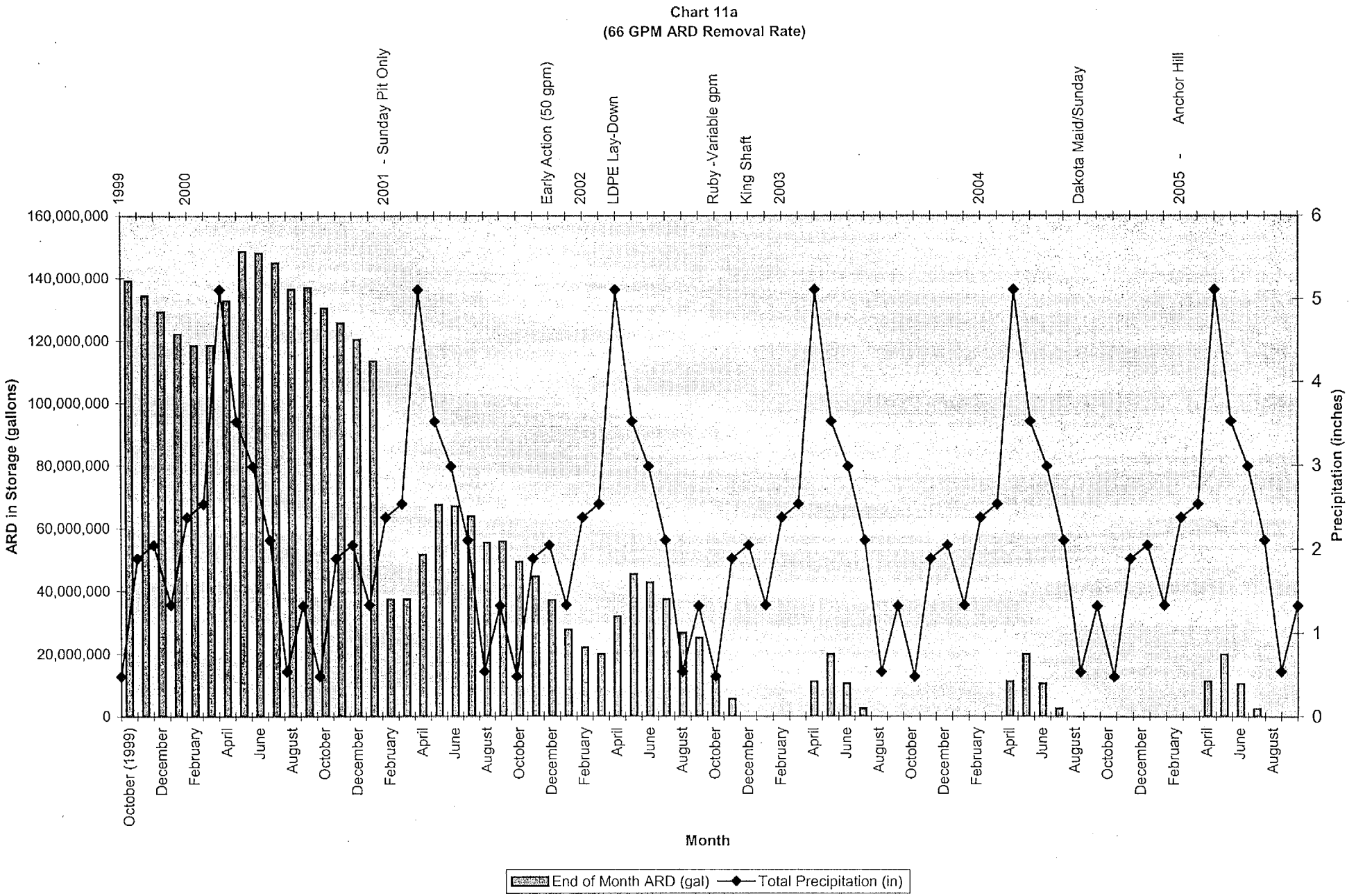
200 GPM Treatment Rate (Treat Sunday Pit ARD Only)
(Current Operations, No Changes)
(Ruby @ 15 GPM Residual Flow)



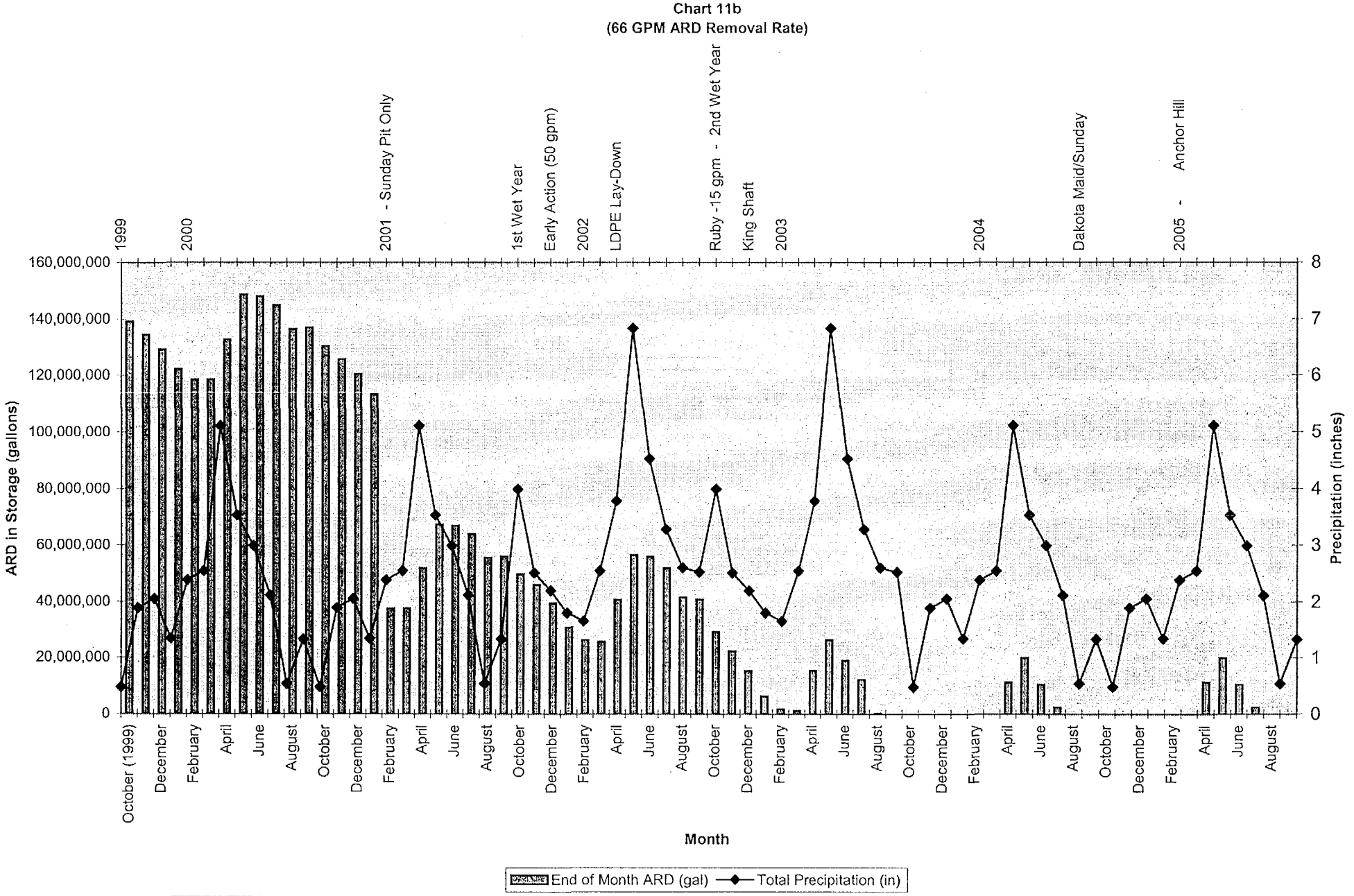
200 GPM Net-Treatment Rate (Treat Sunday Pit ARD Only) with Two Wet Years
(Current Operations, No Changes)
(Ruby @ 15 GPM Residual Flow)



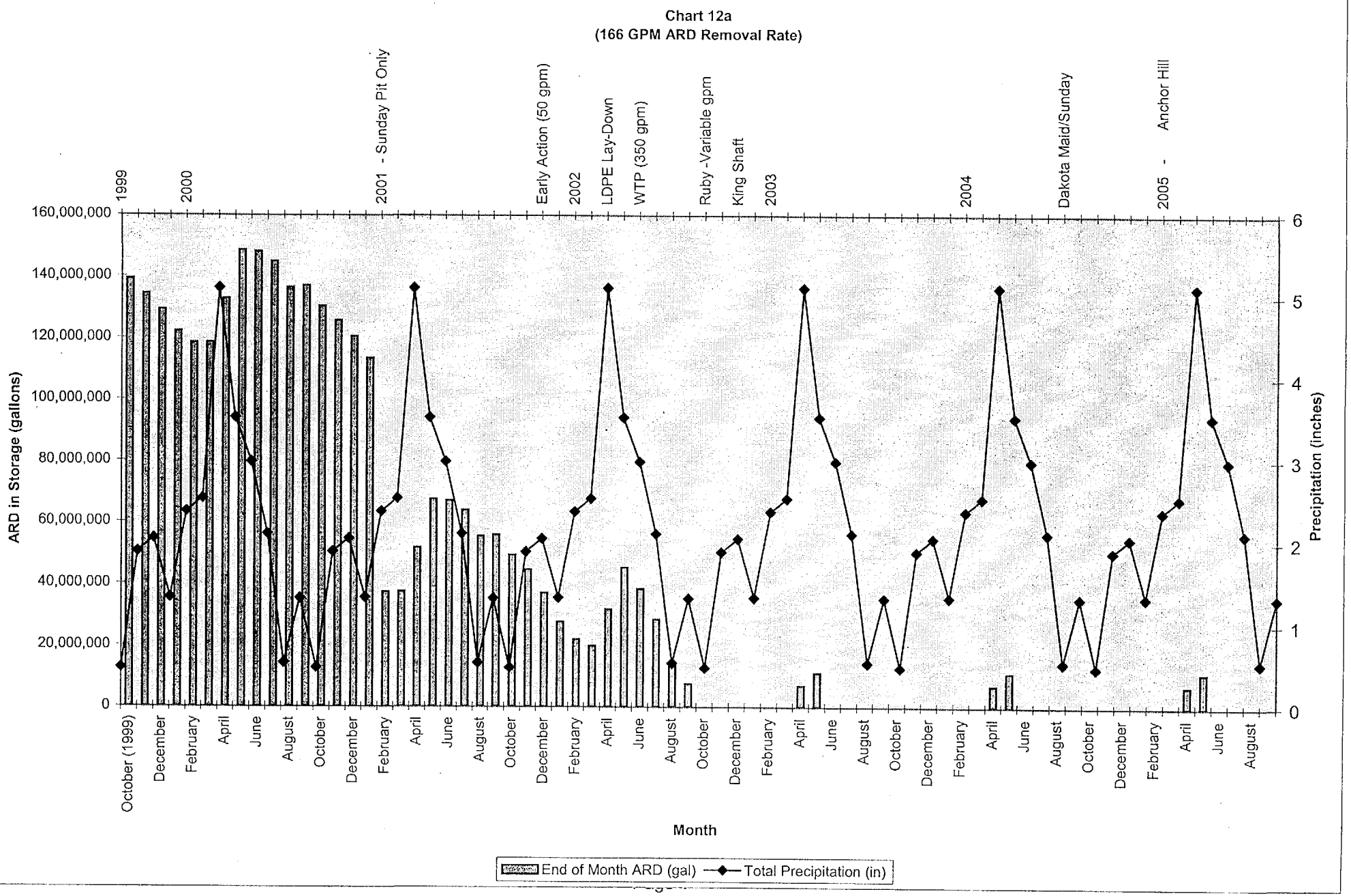
250 GPM Net-Treatment Rate (Treat Sunday Pit ARD Only)
(Current Operations + Filter Press)
(Ruby @ 15 GPM Residual Flow)



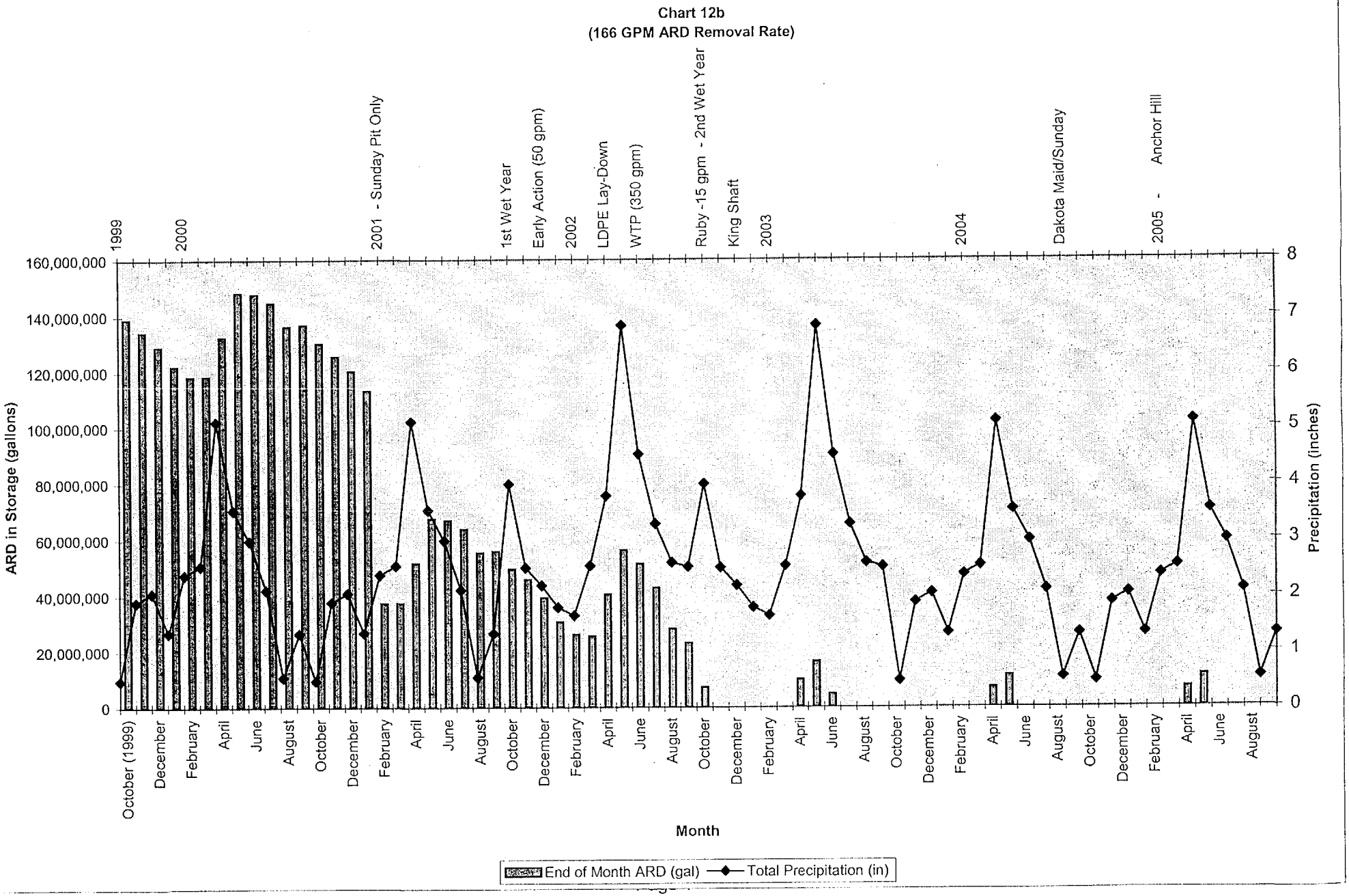
250 GPM Net-Treatment Rate (Treat Sunday Pit ARD Only) with Two Wet Years
(Current Operations + Filter Press)
(Ruby @ 15 GPM Residual Flow)



350 GPM Net-Treatment Rate (Treat Sunday Pit ARD Only)
(Current Operations + Filter Press + 100 GPM Plant + Ruby Cap Reduction)
(Ruby @ 15 GPM Residual Flow)



350 GPM Net-Treatment Rate (Treat Sunday Pit ARD Only) with Two Wet Years
(Current Operations + Filter Press + 100 GPM Plant)
(Ruby @ 15 GPM Residual Flow)



Appendix D
Present Worth Analysis of Retained Alternatives

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final ARD WTP FFS (-30% to +50%)*

Table D-1. Comparison of Present Worth Costs for Metal Hydroxide Precipitation

Q (gpm)	Capital Cost ($)	Annual O&M Cost ($)	Present Worth Cost - 90% (mil $)	Present Worth Cost - 95% ($)	Present Worth Cost - 99% ($)
	NaOH Precipitation				
250	1,364,000	3,787,000	13.87	--	--
300	1,690,000	4,030,000	6.20	9.79	--
400	2,261,000	4,533,000	5.92	8.02	--
500	2,462,000	5,020,000	6.12	6.52	16.73
600	3,183,000	5,523,000	5.89	6.77	7.65
700	3,808,000	6,009,000	6.75	6.75	8.19
800	4,313,000	6,512,000	6.98	6.98	9.06
	CaO Addition				
250	2,054,000	2,938,000	11.76	--	--
300	2,496,000	3,001,000	5.85	8.53	--
400	3,078,000	3,139,000	5.61	7.07	--
500	3,277,000	3,258,000	5.65	5.91	12.54
600	4,352,000	3,396,000	6.02	6.29	7.10
700	4,954,000	3,519,000	6.68	6.68	7.52
800	5,412,000	3,656,000	6.91	6.91	8.08

Table D-2. Probabilistic Analysis for De-Watering Storage

Q (gpm)	Probability of less than # of years to de-water storage		
	90	95	99
250	3.7	--	--
300	1.1	2.1	--
400	0.8	1.3	--
500	0.7	0.8	3.1
600	0.5	0.6	0.8
700	0.5	0.5	0.7
800	0.4	0.4	0.7

"-" denotes a period >5 years to treat the present storage volume on-site (approximately 110 million gallons)

Table D-3. Probability of Untreated Release During a Year

Q (gpm)	Untreated Release	No Untreated Release
0	100%	0%
100	100%	0%
200	21%	79%
250	13%	87%
300	8%	92%
400	5%	95%
500	3%	97%
600	0.5%	100%
700	0.5%	100%
800	0.0%	100%

Table D-4. Summary of Alternative Treatment Scenarios at 300 gpm

Alternative	Capital Cost	Annual O&M Cost	$/1000 gal	Present Worth Cost [1]
Alternative 1 - No Action	0	194,000	n/a	476,000 (2)
Alternative 3a - Divert ARD Flow from Hoodoo Gulch to Sunday Pit and Install ARD Diversion Ditch At Pond C	262,000	1,900	n/a	266,000
Alternative 3b - Divert ARD Flow from Hoodoo Gulch to Strawberry Pond and Install ARD Diversion Ditch At Pond C	307,000	1,900	n/a	311,000
Alternative 6a - Upgrade Existing Caustic Chemical Precipitation ARD WTP With Additional Treatment Train and Filtration (ARAR waiver)	1,690,000	4,030,000	$25.56	9,789,000
Alternative 6b - Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Precipitation and upgrade With Additional Treatment Train and Filtration (ARAR waiver)	2,496,000	3,001,000	$19.03	8,527,000
Alternative 6c - Construct New Proprietary Microencapsulation/Precipitation ARD WTP (ARAR Waiver)	1,985,000	3,332,000	$21.13	8,681,000
Alternative 6d - Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (ARAR Waiver)	2,475,000	2,846,000	$18.05	8,195,000

Notes:

(1) Present Worth analyis assumes annual O&M costs over period of time (years) required to de-water the site's water storage at a certain flow rate (250 gpm to 800 gpm):

Probability of de-watering the site (90, 95 or 99%) =	95
Treatment Capacity (gpm, increments of 100) =	300
Years required to de-water site (90%) =	1.1
Years required to de-water site (95%) =	2.1
Years required to de-water site (99%) =	--

(2) Present Worth analyis for Alternative 1 assumes annual O&M costs and periodic costs for an assumed 5-year interim period.

General Notes

1 PW - previous work; VQ - vendor quote (adjusted for labor and equipment as a percentage of material costs):
percentage estimated based upon equipment installation: 25%

2 Sludge materials will be disposed of on-site; costs incurred for loader, truck, and operators included as Item 2.3.

3 Existing WTP is capable of treating 300 gpm with additional capital cost accounted for by this analysis.

4 Annual O&M costs are estimated using labor rates and breakdown of ODC/IDC based on previous work.

5 Electrical utility costs currently are $0.0437/kWhr [Rolland (BOR), 2001). FFS costs based on hours of operation and adjusted by 50 percent to $0.0655/kWhr.

6 Capital costs for the following items are estimated as a percentage of total Process/Mechancial costs:

Electrical	12%
Instrumentation and Controls	15%

7 Annual O&M costs also include snow removal equipment (Items 2.5.2.1 and 2.5.2.2) and labor (Item 2.3).

8 Valves and appurtenances are estimated as a percentage of the total piping costs: 60%

9 HDPE pipe will be used for buried pipes; costs are estimated based on excavation, bedding, and backfill/compaction.

10 Construction Prorates:

General Conditions (Overhead)[a]	20%	
Contractor's Profit [b]	10%	
Scope and Bid Design Contingency [c]	20%	(10% design + 10% bid)
Adjusted conversion[d]	58.4%	

(a) General conditions includes cost associated with permits, licenses, insurance, bonds, environmental safe guards, sediment and drainage control, and special construction practices to maintain continued plant operations.

(b) Contractor's overhead and profit include costs for mobilization/demobilization, administration, and contractor/subcontractor overhead costs and profits.

(c) A 20 percent design contingency was used for this estimate based on the conceptual nature of the information developed for this analysis.

(d) The adjusted conversion value is a function of the application of the prorates to total project costs per the *Guide to Developing and Documenting Cost Estimates During the Feasibility Study (EPA, 2000).*

11 Engineering Costs Prorates:

total project raw costs and Construction Prorates*:

Remedial Design	8%
Project Management	5%
Construction Management	6%
Total	19.0%

* Annual O&M costs for Project Management and Remedial Design included as Item 2.4 as a variance from *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA, 2000); only Construction Management costs incorporated as prorate.

12 Addition of lime slaker, slurry mixing tank, and feed pump; also includes electrical, I&C, and installation.

13 Sampling costs based on weekly compliance monitoring, including tri-annual QA/QC costsfor outside laboratory analysis. For NO ACTION alternative, monitoring is reduced to monthly basis.

14 Operational sampling estimated as 150% of compliance monitoring costs to allow for weekly influent monitoring and miscellaneous process analyses.

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final ARD WTP FFS (-30% to +50%)*

Alternative 1 - No Action

The No Action alternative would discontinue the existing surface water and ARD collection and treatment measures. There would be no change in the aqueous contaminant concentrations because no treatment, containment, or removal of ARD is included in this alternative. For the interim period (approximately 5 years), site security, sampling and report preparation are included.

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	**CAPITAL COSTS**			**Total**	**0**	
2	**ANNUAL O&M COSTS**					
2.1	MONITORING	1	LS	8,000	*8,000*	General Note 13
2.2	STAFF					
2.2.1	Security	2	annual salary	34,200	*68,400*	General Note 4
2.3	INDIRECT COSTS					
2.3.1	Radio and Pager Rental	1	LS	2,000	*2,000*	General Note 4
2.3.2	Vehicles					
2.3.2.1	Pickup Truck	12	months	750	*9,000*	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.3.2.2	Fuel	1	year	22,000	*22,000*	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.3.3	Utilities					
2.3.3.1	Water	12	months	100	*1,200*	General Note 4
2.3.3.2	Phone	12	months	200	*2,400*	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.3.3.3	Electrical	12	months	200	*2,400*	Estimated
	Annual O&M Costs			**Subtotal**	**116,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.4	CONSTRUCTION PRORATES	1	LS	69,000	*69,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	24,000		
	Contractor's Profit [b]		10% of Total Cost + GC	14,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	31,000		
2.5	ENGINEERING COSTS	1	LS	9,000	*9,000*	see Note A below
	Project Management		5% of Total Cost + Const Prorates	9,000		
	ANNUAL O&M COSTS			**Total**	**194,000**	
3	**PERIODIC COSTS**					
3.1	Five-Year Review Reports	1	LS	11,000	*11,000*	
	Periodic Costs			**Subtotal**	**11,000**	
3.2	CONSTRUCTION PRORATES	1	LS	9,000	*9,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	3,000		
	Contractor's Profit [b]		10% of Total Cost + GC	2,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	4,000		
3.3	ENGINEERING COSTS	1	LS	1,000	*1,000*	see Note A below
	Project Management		5% of Total Cost + Const Prorates	1,000		
	PERIODIC COSTS			**Total**	**21,000**	

Notes

A Engineering Cost Factor:

Costs include the following items applied as a percentage of total project raw costs and Construction Prorates*:

Remedial Design	0%
Project Management	5%
Construction Management	0%
Total	5%

* Only Project Management costs incorporated as prorate.

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project: *Gilt Edge Mine* Updated: *7-Jun-01*

Project #: *4000-30291* Estimator: *BCD*

Location: *Lawrence County, South Dakota* Project Status: *Final ARD WTP FFS (-30% to +50%)*

Alternative 3a - Divert ARD Flow from Hoodoo Gulch to Sunday Pit and Install ARD Diversion Ditch At Pond C

The seepage from Hoodoo Gulch would be collected within a collection (sump) system prior to convergence with Strawberry Creek. Collected water would flow by gravity to a storage tank and subsequently be pumped to Sunday Pit. A HDPE lined interception channel would be constructed to collect seepage upstream of Pond C as surface water run-off. The channel would flow to the south, with discharge to Pond D.

Cumulative seepage flow rate, gpm = 10 gpm

Transfer flow rate, gpm = 30 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Sumps (Hoodoo Gulch)	*5 total*				
1.1.1.1	Excavation	5	CY	52	1,000	Means Heavy Construction Cost Data (2001), 02240-500-0300
1.1.1.2	Backfill	4	CY	22	1,000	Means Heavy Construction Cost Data (2001), 02315-100-0300
1.1.2	Pond C Collection Ditch					
1.1.2.1	Excavation	500	CY	4.05	3,000	Means Heavy Construction Cost Data (2001), 02315-900-0050
1.1.2.2	Compaction	500	CY	2.71	2,000	Means Heavy Construction Cost Data (2001), 02315-900-1900
1.1.2.3	Trimming	8625	SF	0.42	4,000	Means Heavy Construction Cost Data (2001), 02315-900-2100
1.1.3	Piping (Trenching, Backfill, and Bedding)					
1.1.3.1	Sump Collectors	350	LF	3.57	2,000	Means Heavy Construction Cost Data (2001), 02315-940-0700, -1700, and -130-0200
1.1.3.2	Main Collector	900	LF	3.57	4,000	Means Heavy Construction Cost Data (2001), 02315-940-0700, -1700, and -130-0200
1.1.3.3	Transfer to Sunday Pit	2300	LF	2.05	5,000	Means Heavy Construction Cost Data (2001), 02315-940-2850 and -130-0200
				Subtotal	*22,000*	
1.2	STRUCTURAL					
1.2.1	Concrete Sump	5	EA	1,054	6,000	Means Heavy Construction Cost Data (2001), 02630-200-0800
1.2.1.1	HDPE Liner for Sump	250	SF	7.67	2,000	based on Means (2001), 02660-400-0200 and $60/hr at 5hrs per sump
1.2.2	HDPE Lining for Pond C Collection Ditch	10875	SF	1.05	12,000	Means Heavy Construction Cost Data (2001), 02630-400-0200
1.2.3	Concrete Foundation for Storage Tank	3	CY	161	500	Means Heavy Construction Cost Data (2001), 03300-130-4050
				Subtotal	*21,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Piping					
1.3.1.1	CPVC - 1" (Sump Collectors)	350	LF	2.45	900	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2100
1.3.1.2	CPVC - 2" (Main Collection Header)	900	LF	4.65	5,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2120
1.3.1.3	CPVC - 3" (Transfer to Sunday Pit)	2300	LF	9.10	21,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2160
1.3.1.4	Valves and Appurtenances	1	LS	15,600	16,000	General Note 8
1.3.2	Storage Tank	1	LS	10,000	10,000	VQ - General Note 1
1.3.3	Submersible Pump	1	EA	4,500	5,000	VQ - General Note 1
				Subtotal	*58,000*	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.4	ELECTRICAL	1	LS	24,000	*24,000*	see Note A below
1.5	INSTRUMENTATION and CONTROLS	1	LS	12,000	*12,000*	see Note A below
	Capital Costs			**Subtotal**	**137,000**	
1.6	CONSTRUCTION PRORATES	1	LS	82,000	*82,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	28,000		
	Contractor's Profit [b]		10% of Total Cost + GC	17,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	37,000		
1.7	ENGINEERING COSTS	1	LS	43,000	*43,000*	General Note 11
	Remedial Design		8% of Total Cost + Const Prorates	18,000		
	Project Management		5% of Total Cost + Const Prorates	11,000		
	Construction Management		6% of Total Cost + Const Prorates	14,000		
	CAPITAL COSTS			**Total**	**262,000**	
2	**ANNUAL O&M COSTS**					
2.1	ARD Transfer rom Hoodoo Gulch Seepage Storage Tank to Sunday Pit (at 8 hrs/day)	5	HP	429/(HP*yr)	*1,000*	General Note 5
	Annual O&M Costs			**Subtotal**	**1,000**	
2.2	*CONSTRUCTION PRORATES*	*1*	*LS*	*700*	*700*	*General Note 10*
	General Conditions (Overhead)[a]		20% of Total Cost	200		
	Contractor's Profit [b]		10% of Total Cost + GC	200		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	300		
2.3	ENGINEERING COSTS	1	LS	200	*200*	see Note B below
	Construction Management		6% of Total Cost + Const Prorates	200		
	ANNUAL O&M COSTS			**Total**	**1,900**	

Notes

A Capital costs for the following items are estimated as a percentage of total Process/Mechancial costs and based on remote location of construction from known electrical sources:

Electrical	40%	(Means(2001);based on trenching, conduit, and backfill)
Instrumentation and Controls	20%	

B Technical Services (i.e., Remedial Design, Project Management) not included in this alternative's analysis; accounted for in Alternative 6.

CDM Camp Dresser & McKee Inc.

Preliminary Opinion of Probable Cost

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final ARD WTP FFS (-30% to +50%)*

Alternative 3b - Divert ARD Flow from Hoodoo Gulch to Strawberry Pond and Install ARD Diversion Ditch At Pond C

The seepage from Hoodoo Gulch would be collected within a collection (sump) system prior to convergence with Strawberry Creek. Collected water would gravity-fed to a storage tank and subsequently pumped to Sunday Pit. A HDPE lined interception channel would be constructed to collect seepage upstream of Pond C as surface water run-off. The channel would flow to the south, with discharge to Pond D.

Cumulative seepage flow rate, gpm = 10 gpm

Transfer flow rate, gpm = 30 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	CAPITAL COSTS					
1.1	CIVIL/SITEWORK					
1.1.1	Sumps	*5 total*				
1.1.1.1	Excavation	5	CY	52	1,000	Means Heavy Construction Cost Data (2001), 02240-500-0300
1.1.1.2	Backfill	4	CY	22	1,000	Means Heavy Construction Cost Data (2001), 02315-100-0300
1.1.2	Pond C Collection Ditch					
1.1.2.1	Excavation	500	CY	4.05	3,000	Means Heavy Construction Cost Data (2001), 02315-900-0050
1.1.2.2	Compaction	500	CY	2.71	2,000	Means Heavy Construction Cost Data (2001), 02315-900-1900
1.1.2.3	Trimming	8625	SF	0.42	4,000	Means Heavy Construction Cost Data (2001), 02315-900-2100
1.1.3	Piping (Trenching, Backfill, and Bedding)					
1.1.3.1	Sump Collectors	350	LF	3.57	2,000	Means Heavy Construction Cost Data (2001), 02315-940-0700, -1700, and -130-0200
1.1.3.2	Main Collector	900	LF	3.57	4,000	Means Heavy Construction Cost Data (2001), 02315-940-0700, -1700, and -130-0200
1.1.3.3	Transfer to Sunday Pit	3250	LF	2.05	7,000	Means Heavy Construction Cost Data (2001), 02315-940-2850 and -130-0200
				Subtotal	*24,000*	
1.2	STRUCTURAL					
1.2.1	Concrete Sump	5	EA	1,054	6,000	Means Heavy Construction Cost Data (2001), 02630-200-0800
1.2.1.1	HDPE Liner for Sump	250	SF	7.67	2,000	based on Means (2001), 02660-400-0200 and $60/hr at 5hrs per sump
1.2.2	HDPE Lining for Pond C Collection Ditch	10875	SF	1.05	12,000	Means Heavy Construction Cost Data (2001), 02630-400-0200
1.2.3	Concrete Foundation for Storage Tank	3	CY	161	500	Means Heavy Construction Cost Data (2001), 03300-130-4050
				Subtotal	*21,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Piping					
1.3.1.1	CPVC - 1" (Sump Discharge)	350	LF	2.45	900	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2100
1.3.1.2	CPVC - 2" (Main Collefction Header)	900	LF	4.65	5,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2120
1.3.1.3	CPVC - 3" (Transfer to Sunday Pit)	3250	LF	9.10	30,000	Herco Catalog (1998), p.96 and Means Heavy Construction Data (2001), 02510-840-2160
1.3.1.4	Valves and Appurtenances	1	LS	21,000	21,000	General Note 8
1.3.2	Storage Tank	1	LS	10,000	10,000	VQ - General Note 1
1.3.3	Submersible Pump	1	EA	4,500	5,000	VQ - General Note 1
				Subtotal	*72,000*	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.4	ELECTRICAL	1	LS	29,000	*29,000*	see Note A below
1.5	INSTRUMENTATION and CONTROLS	1	LS	15,000	*15,000*	see Note A below
	Capital Costs			**Subtotal**	**161,000**	
1.6	CONSTRUCTION PRORATES	1	LS	96,000	*96,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	33,000		
	Contractor's Profit [b]		10% of Total Cost + GC	20,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	43,000		
1.7	ENGINEERING COSTS	1	LS	50,000	*50,000*	General Note 11
	Remedial Design		8% of Total Cost + Const Prorates	21,000		
	Project Management		5% of Total Cost + Const Prorates	13,000		
	Construction Management		6% of Total Cost + Const Prorates	16,000		
	CAPITAL COSTS			**Total**	**307,000**	
2	**ANNUAL O&M COSTS**					
2.1	ARD Transfer rom Hoodoo Gulch Seepage Storage Tank to Strawberry Pond (at 8 hrs/day)	5	HP	429/(HP*yr)	*1,000*	General Note 5
	Annual O&M Costs			**Subtotal**	**1,000**	
2.2	CONSTRUCTION PRORATES	1	LS	700	*700*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	200		
	Contractor's Profit [b]		10% of Total Cost + GC	200		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	300		
2.3	ENGINEERING COSTS	1	LS	200	*200*	see Note B below
	Construction Management		6% of Total Cost + Const Prorates	200		
	ANNUAL O&M COSTS			**Total**	**1,900**	

Notes

A Capital costs for the following items are estimated as a percentage of total Process/Mechancial costs and based on remote location of construction from known electrical sources:

Electrical 40% (Means(2001);based on trenching, conduit, and backfill)

Instrumentation and Controls 20%

B Technical Services (i.e., Remedial Design, Project Management) not included in this alternative's analysis; accounted for in Alternative 6.

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.4	ELECTRICAL	1	LS	29,000	*29,000*	see Note A below
1.5	INSTRUMENTATION and CONTROLS	1	LS	15,000	*15,000*	see Note A below
	Capital Costs			**Subtotal**	**161,000**	
1.6	CONSTRUCTION PRORATES	1	LS	96,000	*96,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	33,000		
	Contractor's Profit [b]		10% of Total Cost + GC	20,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	43,000		
1.7	ENGINEERING COSTS	1	LS	50,000	*50,000*	General Note 11
	Remedial Design		8% of Total Cost + Const Prorates	21,000		
	Project Management		5% of Total Cost + Const Prorates	13,000		
	Construction Management		6% of Total Cost + Const Prorates	16,000		
	CAPITAL COSTS			**Total**	**307,000**	
2	**ANNUAL O&M COSTS**					
2.1	ARD Transfer rom Hoodoo Gulch Seepage Storage Tank to Strawberry Pond (at 8 hrs/day)	5	HP	429/(HP*yr)	*1,000*	General Note 5
	Annual O&M Costs			**Subtotal**	**1,000**	
2.2	CONSTRUCTION PRORATES	1	LS	700	*700*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	200		
	Contractor's Profit [b]		10% of Total Cost + GC	200		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	300		
2.3	ENGINEERING COSTS	1	LS	200	*200*	see Note B below
	Construction Management		6% of Total Cost + Const Prorates	200		
	ANNUAL O&M COSTS			**Total**	**1,900**	

Notes

A Capital costs for the following items are estimated as a percentage of total Process/Mechancial costs and based on remote location of construction from known electrical sources:

Electrical	40%	(Means(2001);based on trenching, conduit, and backfill)
Instrumentation and Controls	20%	

B *Technical Services (i.e., Remedial Design, Project Management) not included in this alternative's analysis; accounted for in Alternative 6.*

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.7.1	Sludge Recycle Pump	1	EA	16,875	17,000	VQ - General Note 1
1.3.7.2	Sludge-to-Waste Pump	2	EA	16,875	34,000	VQ - General Note 1
1.3.7.3	Post Clarifier Acid Addition					
1.3.7.3.1	Acid Storage Tank	1	EA	14,000	14,000	VQ - General Note 1
1.3.7.3.2	Metering Pump	1	EA	5,600	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.7.3.3	Rapid Mix Tank	1	EA	4,500	5,000	VQ - General Note 1
1.3.7.3.4	Mixer	1	EA	2,500	3,000	VQ - General Note 1
1.3.8	Disc Filter	1	LS	108,750	109,000	VQ - General Note 1
1.3.9	Settled Water Storage Tank	1	LS	11,500	12,000	VQ - General Note 1
1.3.10	Sludge Conditioning/Handling Equipment					
1.3.10.1	Sludge Storage Tank	1	LS	21,500	22,000	VQ - General Note 1
1.3.10.2	Sludge Transfer Pump to Filter Press	1	EA	16,875	17,000	VQ - General Note 1
1.3.10.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ - General Note 1
1.3.10.4	Polymer Activation/Feed System	1	LS	6,500	7,000	VQ - General Note 1
1.3.10.5	Filter Press	1	EA	175,000	175,000	VQ - General Note 1
1.3.10.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ - General Note 1
1.3.11	Piping					
1.3.11.1	PVC - 1"	80	LF	9	800	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.11.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.11.3	PVC - 4"	300	LF	15	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.11.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.11.5	PVC - 8"	100	LF	33	4,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.11.6	PVC - 12"	0	LF	66	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.11.7	HDPE - 2"	0	LF	15	0	General Note 9
1.3.11.8	HDPE - 4"	0	LF	23	0	General Note 9
1.3.11.9	HDPE - 8"	200	LF	32	7,000	General Note 9
1.3.11.10	Valves and Appurtenances	1	LS	11,000	11,000	General Note 8
				Subtotal	*654,000*	
1.4	ELECTRICAL	1	LS	75,200	*75,200*	General Note 6
1.5	INSTRUMENTATION and CONTROLS	1	LS	93,900	*93,900*	General Note 6
	Capital Costs			**Subtotal**	**895,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.6	CONSTRUCTION PRORATES	1	LS	524,000	*524,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	179,000		
	Contractor's Profit[b]		10% of Total Cost + GC	108,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	237,000		
1.7	ENGINEERING COSTS	1	LS	271,000	*271,000*	General Note 11
	Remedial Design		8% of Total Cost + Const Prorates	114,000		
	Project Management		5% of Total Cost + Const Prorates	71,000		
	Construction Management		6% of Total Cost + Const Prorates	86,000		
	CAPITAL COSTS			**Total**	**1,690,000**	
2	**ANNUAL O&M COSTS**					
2.1	CHEMICALS					
2.1.1	Hydroxide (Caustic)	300	gpm	2713	814,000	VQ - General Note 1
2.1.2	Polymer	300	gpm	174	53,000	VQ - General Note 1
2.1.3	Acid	300	gpm	17	6,000	VQ - General Note 1
				Subtotal	*873,000*	
2.2	SLUDGE DISPOSAL		see General Note 2			
2.3	MONITORING/SAMPLING					
2.3.1	Compliance Monitoring	1	LS	27,000	*27,000*	General Note 13
2.3.2	Operational Monitoring	1	LS	41,000	*41,000*	General Note 14
				Subtotal	*68,000*	
2.4	STAFF					
2.4.1	Plant Engineer	1	annual salary	82,500	83,000	General Note 4
2.4.2	Operators	8	annual salary	38,100	305,000	General Note 4
2.4.3	Mechanic	2	annual salary	59,800	120,000	General Note 4
2.4.4	Chemist	1	annual salary	39,600	40,000	General Note 4
2.4.5	Security	2	annual salary	34,200	69,000	General Note 4
2.4.6	Administrative Assistant	1	annual salary	25,000	25,000	General Note 4
				Subtotal	*642,000*	
2.5	OTHER DIRECT COSTS					
2.5.1	Project Manager	1040	hours per year	40	42,000	General Note 4
2.5.2	Junior Engineer	240	hours per year	30	8,000	General Note 4
2.5.3	Project Engineer	240	hours per year	50	13,000	General Note 4
				Subtotal	*63,000*	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.6	INDIRECT COSTS					
2.6.1	Radio and Pager Rental	1	LS	2,000	2,000	General Note 4
2.6.2	Vehicles					
2.6.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.6.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.6.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.6.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.6.2.5	Fuel	1	year	138,000	138,000	based on hourly costs for above Items, 8 hrs/365 days
2.6.3	Road Grading	4	per year	5,000	20,000	General Note 4
2.6.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.6.5	Supplies	1	LS	132,000	132,000	General Note 4
2.6.6	Utilities					
2.6.6.1	Water	1	LS	5,000	5,000	General Note 4
2.6.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.6.6.3	Electrical					
2.6.6.3.1	Pumps					
2.6.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	General Note 5; 8 hours per day average over year
2.6.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	General Note 5; 24 hours/day, 365 days/year
2.6.6.3.1.3	Heap Leach Recirculating (On-Solution)	150	HP	429/(HP*yr)	38,000	General Note 5; October through April, 24 hours/day
2.6.6.3.1.4	Heap Leach Recirculating (concurrently w/2.5.6.3.1.3)	15	HP	429/(HP*yr)	4,000	General Note 5; October through April, 24 hours/day
2.6.6.3.1.5	Sludge Recycle	15	HP	429/(HP*yr)	7,000	General Note 5
2.6.6.3.1.6	Sludge-to-Waste	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.3.1.7	Sludge Storage to Filter Press	10	HP	429/(HP*yr)	5,000	General Note 5
2.6.6.3.1.8	Filtrate Pump	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.3.2	Chemical Feed Systems					
2.6.6.3.2.1	Sodium Hydroxide Feed	2	HP	429/(HP*yr)	1,000	General Note 5
2.6.6.3.2.2	Polymer Activation/Feed System	1.5	HP	429/(HP*yr)	1,000	General Note 5
2.6.6.3.2.3	Sludge Polymer Activation/Feed System	1.5	HP	429/(HP*yr)	700	General Note 5
2.6.6.3.3	Mixers					
2.6.6.3.3.1	Sludge Mixing Tank	2	HP	429/(HP*yr)	1,000	General Note 5
2.6.6.3.3.2	Sodium Hydroxide Rapid Mix	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.3.3.3	Flocculation	2	HP	429/(HP*yr)	1,000	General Note 5
2.6.6.3.3.4	Sludge Storage Tank	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.3.3.5	Clarifier Rake	2	HP	429/(HP*yr)	900	General Note 5
2.6.6.3.4	Sludge Handling Equipment					
2.6.6.3.4.1	Filter Press	7	HP	429/(HP*yr)	4,000	General Note 5
2.6.6.4	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for new WTP building
				Subtotal	*754,000*	
	Annual O&M Costs			**Subtotal**	**2,400,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.7	CONSTRUCTION PRORATES	1	LS	1,402,000	*1,402,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	480,000		
	Contractor's Profit[b]		10% of Total Cost + GC	288,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	634,000		
2.8	ENGINEERING COSTS	1	LS	228,000	*228,000*	General Note 11
	Construction Management		6% of Total Cost + Const Prorates	228,000		
	ANNUAL O&M COSTS			**Total**	**4,030,000**	
				per month	**$335,833**	
				per 1,000 gallons	**$25.56**	

Project:	*Gilt Edge Mine*	Updated:	*7-Jun-01*
Project #:	*4000-30291*	Estimator:	*BCD*
Location:	*Lawrence County, South Dakota*	Project Status:	*Final ARD WTP FFS (-30% to +50%)*

Alternative 6b - Convert Existing Caustic Chemical Precipitation ARD WTP to Lime Precipitation and upgrade With Additional Treatment Train and Filtration (ARAR waiver)

This alternative would consist of conversion of the existing caustic-addition treatment processt to a lime-addition precipitation treatment process. Sludge residuals are disposed of at an on-stie location (e.g., dewatered, lined ponds). Optimized operations include addition of a lime slaking system; polishing filter; sludge residual treatment using a filter press; and annual O&M operations for the treatment plant including utilities, staff, administration, site snow removal, and weekly monitoring sampling and support.

Existing Treatment Capacity, gpm =	300 gpm
NewTreatment Capacity, gpm =	0 gpm
Total Treatment Capacity, gpm =	300 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	**CAPITAL COSTS**					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	243	CY	10	3,000	PW - General Note 1
1.1.2	Fine Grading	243	SY	0.85	300	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	81	CY	20	2,000	PW - General Note 1
1.1.4	Aggregate below SOG	81	CY	19	2,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	1,000	1,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*8,300*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	2000	SF	10	20,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building/Clarifier/Sludge Storage Foundations	182	CY	250	46,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*66,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	0	EA	0	0	VQ - General Note 1
1.3.2	Sludge Mixing Tank	0	LS	0	0	VQ - General Note 1
1.3.2.1	Mixer	0	LS	0	0	VQ - General Note 1
1.3.3	Rapid Mix Tank	0	LS	0	0	VQ - General Note 1
1.3.3.1	Mixer	0	LS	0	0	VQ - General Note 1
1.3.4	Polymer Storage Tank	0	LS	0	0	VQ - General Note 1
1.3.4.1	Polymer Activation/Feed System	0	LS	0	0	VQ - General Note 1
1.3.5	Flocculation Tank	0	LS	0	0	VQ - General Note 1
1.3.5.1	Mixer	0	LS	0	0	VQ - General Note 1
1.3.6	Circular Clarifier	1	EA	184,000	184,000	VQ - General Note 1
1.3.6.1	Sludge Recycle Pump	1	EA	16,875	17,000	VQ - General Note 1
1.3.6.2	Sludge-to-Waste Pump	2	EA	16,875	34,000	VQ - General Note 1

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.6.3	Post Clarifier Acid Addition					
1.3.6.3.1	Acid Storage Tank	1	EA	14,000	14,000	VQ - General Note 1
1.3.6.3.2	Metering Pump	1	EA	5,600	6,000	Means (2000), Env. Cost Data, 33-32-0122
1.3.6.3.3	Rapid Mix Tank	1	EA	4,500	5,000	VQ - General Note 1
1.3.6.3.4	Mixer	1	EA	2,500	3,000	VQ - General Note 1
1.3.7	Disc Filter	1	LS	108,750	109,000	VQ - General Note 1
1.3.8	Settled Water Storage Tank	1	LS	10,000	10,000	VQ - General Note 1
1.3.9	Sludge Conditioning/Handling Equipment					
1.3.9.1	Sludge Storage Tank	1	LS	47,921	48,000	VQ - General Note 1
1.3.9.2	Sludge Transfer Pump to Filter Press	1	EA	16,875	17,000	VQ - General Note 1
1.3.9.3	Polymer Storage Tank	1	EA	3,750	4,000	VQ - General Note 1
1.3.9.4	Polymer Activation/Feed System	1	LS	6,500	7,000	VQ - General Note 1
1.3.9.5	Filter Press	1	EA	225,000	225,000	VQ - General Note 1
1.3.9.6	Filtrate Return Pump	1	EA	16,875	17,000	VQ - General Note 1
1.3.10	Piping					
1.3.10.1	PVC - 1"	80	LF	9	800	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.10.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.10.3	PVC - 4"	300	LF	15	5,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.10.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.10.5	PVC - 8"	100	LF	33	4,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.10.6	PVC - 12"	0	LF	66	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.10.7	HDPE - 2"	0	LF	15	0	General Note 9
1.3.10.8	HDPE - 4"	0	LF	23	0	General Note 9
1.3.10.9	HDPE - 8"	200	LF	32	7,000	General Note 9
1.3.10.10	Valves and Appurtenances	1	LS	11,000	11,000	General Note 8
				Subtotal	*727,800*	
1.4	EXISTING WTP CONVERSION	1	LS	331,000	*331,000*	General Note 12
1.4.1	Lime Slaker, Slurry Mixing Tank, and Feed Pump	1	LS	260,000		VQ - General Note 1
1.4.2	Electrical	1	LS	32,000		General Note 6
1.4.3	Instrumentation and Controls	1	LS	39,000		General Note 6
1.5	ELECTRICAL	1	LS	84,000	*84,000*	General Note 6
1.6	INSTRUMENTATION and CONTROLS	1	LS	105,000	*105,000*	General Note 6
	Capital Costs			**Subtotal**	**1,323,000**	
1.7	CONSTRUCTION PRORATES	1	LS	774,000	*774,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	265,000		
	Contractor's Profit [b]		10% of Total Cost + GC	159,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	350,000		

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.8	ENGINEERING COSTS	1	LS	399,000	*399,000*	General Note 11
	Remedial Design	8% of Total Cost + Const Prorates		168,000		
	Project Management	5% of Total Cost + Const Prorates		105,000		
	Construction Management	6% of Total Cost + Const Prorates		126,000		
	CAPITAL COSTS			**Total**	**2,496,000**	
2	**ANNUAL O&M COSTS**					
2.1	CHEMICALS					
2.1.1	Hydrated lime	300	gpm	542	163,000	VQ - General Note 1
2.1.2	Polymer	300	gpm	174	53,000	VQ - General Note 1
2.1.3	Acid	300	gpm	13	4,000	VQ - General Note 1
				Subtotal	*220,000*	
2.2	SLUDGE DISPOSAL		see General Note 2			
2.3	MONITORING/SAMPLING					
2.3.1	Compliance Monitoring	1	LS	27,000	*27,000*	General Note 13
2.3.2	Operational Monitoring	1	LS	41,000	*41,000*	General Note 14
				Subtotal	*68,000*	
2.4	STAFF					
2.4.1	Plant Engineer	1	annual salary	82,500	83,000	General Note 4
2.4.2	Operators	9	annual salary	38,100	343,000	General Note 4
2.4.3	Mechanic	2	annual salary	59,800	120,000	General Note 4
2.4.4	Chemist	1	annual salary	39,600	40,000	General Note 4
2.4.5	Security	2	annual salary	34,200	69,000	General Note 4
2.4.6	Administrative Assistant	1	annual salary	25,000	25,000	General Note 4
				Subtotal	*680,000*	
2.5	OTHER DIRECT COSTS					
2.5.1	Project Manager	1040	hours per year	40	42,000	General Note 4
2.5.2	Junior Engineer	240	hours per year	30	8,000	General Note 4
2.5.3	Project Engineer	240	hours per year	50	13,000	General Note 4
				Subtotal	*63,000*	
2.6	INDIRECT COSTS					
2.6.1	Radio and Pager Rental	1	LS	2,000	2,000	General Note 4

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.6.2	Vehicles					
2.6.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.6.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.6.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.6.2.4	Pickup Truck (3 total)	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.6.2.5	Fuel	1	year	138,000	138,000	based on hourly costs for above Items, 8 hrs/365 days
2.6.3	Road Grading	4	per year	5,000	20,000	General Note 4
2.6.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.6.5	Supplies	1	LS	132,000	132,000	General Note 4
2.6.6	Utilities					
2.6.6.1	Water	1	LS	5,000	5,000	General Note 4
2.6.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.6.6.3	Electrical					
2.6.6.3.1	Pumps					
2.6.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	General Note 5; 8 hours per day average over year
2.6.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	General Note 5; 24 hours/day, 365 days/year
2.6.6.3.1.3	Heap Leach Recirculating (On-Solution)	150	HP	429/(HP*yr)	38,000	General Note 5; October through April, 24 hours/day
2.6.6.3.1.4	Heap Leach Recirculating (concurrently w/2.5.6.3.1.3)	15	HP	429/(HP*yr)	4,000	General Note 5; October through April, 24 hours/day
2.6.6.3.1.5	Sludge Recycle	15	HP	429/(HP*yr)	7,000	General Note 5
2.6.6.3.1.6	Sludge-to-Waste	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.3.1.7	Sludge Storage to Filter Press	10	HP	429/(HP*yr)	5,000	General Note 5
2.6.6.3.1.8	Filtrate Return Pump	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.3.2	Chemical Feed Systems					
2.6.6.3.2.1	Lime Slaker System	2.5	HP	429/(HP*yr)	2,000	General Note 5
2.6.6.3.2.2	Polymer Activation/Feed System	1.5	HP	429/(HP*yr)	1,000	General Note 5
2.6.6.3.2.3	Sludge Polymer Activation/Feed System	1.5	HP	429/(HP*yr)	700	General Note 5
2.6.6.3.3	Mixers					
2.6.6.3.3.1	Sludge Mixing Tank	2	HP	429/(HP*yr)	1,000	General Note 5
2.6.6.3.3.2	Rapid Mix	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.3.3.3	Flocculation	2	HP	429/(HP*yr)	1,000	General Note 5
2.6.6.3.3.4	Sludge Storage Tank	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.3.3.5	Clarifier Rake	2	HP	429/(HP*yr)	900	General Note 5
2.6.6.3.4	Sludge Handling Equipment					
2.6.6.3.4.1	Filter Press	7	HP	429/(HP*yr)	4,000	General Note 5
2.6.6.4	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for new WTP building
				Subtotal	*755,000*	
	Annual O&M Costs			**Subtotal**	**1,786,000**	
2.7	CONSTRUCTION PRORATES	1	LS	1,045,000	*1,045,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	358,000		
	Contractor's Profit[b]		10% of Total Cost + GC	215,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	472,000		

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.8	ENGINEERING COSTS	1	LS	170,000	*170,000*	General Note 11
	Construction Management	6% of Total Cost + Const Prorates		170,000		
	ANNUAL O&M COSTS			**Total**	**3,001,000**	
				per month	**$250,083**	
				per 1,000 gallons	**$19.03**	

Project: *Gilt Edge Mine*
Project #: *4000-30291*
Location: *Lawrence County, South Dakota*

Updated: *7-Jun-01*
Estimator: *BCD*
Project Status: *Final ARD WTP FFS (-30% to +50%)*

Alternative 6c - Construct New Proprietary Microencapsulation/Precipitation ARD WTP (ARAR Waiver)

This alternative would consist of the construction of a new ARD treatment plant. The treatment process would utilize a proprietary chemical silica reagent to encapsulate metal hydroxides. The metal precipitates would be settled out within sedimentatin basins. Sludge residuals would be disposed at an onsite location. The process train includes the chemical feed system; mix tanks; sedimentation basins; sludge tanks; and all pumps, instrumentation and appurtenances. Also included are annual O&M operations for the treatment plant including utilities, staff, administration, site snow removal, and weekly monitoring sampling and support.

Treatment Capacity, gpm = 300 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	**CAPITAL COSTS**					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	747	CY	10	8,000	PW - General Note 1
1.1.2	Fine Grading	747	SY	1	800	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	249	CY	20	5,000	PW - General Note 1
1.1.4	Aggregate below SOG	249	CY	19	5,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	2,000	2,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*20,800*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	6400	SF	9	58,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building and Tank Foundations	374	CY	250	94,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*152,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ - General Note 1
1.3.2	Micro Encapsulation Process Train, including:	1	LS	750,000	750,000	VQ - General Note 1
	metering equipment					
	chemical storage					
	chemical feed					
	sludge pumps/storage tanks/handling					
	piping					
	instrumentation & controls					
1.3.3	Settled Water Storage Tank	1	LS	21,500	22,000	VQ - General Note 1

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.4	Piping					
1.3.4.1	PVC - 1"	0	LF	9	0	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.4.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.4.3	PVC - 4"	100	LF	15	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.4.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.4.5	PVC - 8"	40	LF	33	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.4.6	PVC - 12"	0	LF	66	0	Estimated from Means (2001), 15108-520-4490
1.3.4.7	HDPE - 2"	0	LF	15	0	General Note 9
1.3.4.8	HDPE - 4"	0	LF	23	0	General Note 9
1.3.4.9	HDPE - 8"	600	LF	32	20,000	General Note 9
1.3.4.10	Valves and Appurtenances	1	LS	15,000	15,000	General Note 8
				Subtotal	*855,000*	
1.5	ELECTRICAL	1	LS	98,000	*98,000*	General Note 6
1.6	INSTRUMENTATION and CONTROLS	1	LS	10,000	*10,000*	General Note 6
	Capital Costs			**Subtotal**	**1,136,000**	
1.7	CONSTRUCTION PRORATES	1	LS	666,000	*666,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	228,000		
	Contractor's Profit[b]		10% of Total Cost + GC	137,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	301,000		
1.8	ENGINEERING COSTS	1	LS	183,000	*183,000*	General Note 11
	Remedial Design		8% of Total Cost + Const Prorates	77,000		
	Project Management		5% of Total Cost + Const Prorates	48,000		
	Construction Management		6% of Total Cost + Const Prorates	58,000		
	CAPITAL COSTS			**Total**	**1,985,000**	
2	**ANNUAL COSTS**					
2.1	CHEMICALS					
2.1.1	Chemicals (inc. proprietary)	300 gpm	gpm	2150	645,000	VQ - reagent dose 2800 ppm at $350/ton
				Subtotal	*645,000*	
2.2	SLUDGE DISPOSAL		see General Note 2			
2.3	MONITORING/SAMPLING					
2.3.1	Compliance Monitoring	1	LS	27,000	*27,000*	General Note 13
2.3.2	Operational Monitoring	1	LS	41,000	*41,000*	General Note 14
				Subtotal	*68,000*	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.4	STAFF					
2.4.1	Plant Engineer	1	annual salary	82,500	83,000	General Note 4
2.4.2	Operators	8	annual salary	38,100	305,000	General Note 4
2.4.3	Mechanic	2	annual salary	59,800	120,000	General Note 4
2.4.4	Chemist	1	annual salary	39,600	40,000	General Note 4
2.4.5	Security	2	annual salary	34,200	69,000	General Note 4
2.4.6	Administrative Assistant	1	annual salary	25,000	25,000	General Note 4
				Subtotal	*642,000*	
2.5	OTHER DIRECT COSTS					
2.5.1	Project Manager	1040	hours per year	40	42,000	General Note 4
2.5.2	Junior Engineer	240	hours per year	30	8,000	General Note 4
2.5.3	Project Engineer	240	hours per year	50	13,000	General Note 4
				Subtotal	*63,000*	
2.6	INDIRECT COSTS					
2.6.1	Radio and Pager Rental	1	LS	2,000	2,000	General Note 4
2.6.2	Vehicles					
2.6.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.6.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.6.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.6.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.6.2.5	Fuel	1	year	138,000	138,000	based on hourly costs for above Items, 8 hrs/365 days
2.6.3	Road Grading	4	per year	5,000	20,000	General Note 4
2.6.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.6.5	Supplies	1	LS	131,800	132,000	General Note 4
2.6.6	Utilities					
2.6.6.1	Water	1	LS	5,000	5,000	General Note 4
2.6.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140
2.6.6.3	Electrical					
2.6.6.3.1	Pumps					
2.6.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	General Note 5; 8 hours per day average over year
2.6.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	General Note 5; 24 hours/day, 365 days/year
2.6.6.3.1.3	Heap Leach Recirculating (On-Solution)	150	HP	429/(HP*yr)	38,000	General Note 5; October through April, 24 hours/day
2.6.6.3.1.4	Heap Leach Recirculating (concurrently w/2.5.6.3.1.3)	15	HP	429/(HP*yr)	4,000	General Note 5; October through April, 24 hours/day
2.6.6.3.2	Microencapsulation Process Train	15	HP	429/(HP*yr)	7,000	General Note 5
2.6.6.4	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for new WTP building
				Subtotal	*606,000*	
	Annual O&M Costs			**Subtotal**	**2,024,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.7	CONSTRUCTION PRORATES	1	LS	1,183,000	*1,183,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	405,000		
	Contractor's Profit[b]		10% of Total Cost + GC	243,000		
	Scope and Bid Design Contingency[c]		20% of Total Cost + GC + Profit	535,000		
2.8	ENGINEERING COSTS	1	LS	193,000	*193,000*	General Note 11
	Construction Management		6% of Total Cost + Const Prorates	193,000		
	ANNUAL O&M COSTS			**Total**	**3,332,000**	
				per month	***$277,667***	
				per 1,000 gallons	**$21.13**	

Project: *Gilt Edge Mine* Updated: *7-Jun-01*
Project #: *4000-30291* Estimator: *BCD*
Location: *Lawrence County, South Dakota* Project Status: *Final ARD WTP FFS (-30% to +50%)*

Alternative 6d - Construct New Optimized Chemical Precipitation ARD WTP Using Proprietary Metals Coordination Process and Microfiltration (ARAR Waiver)

This alternative would consist of the construction of a new ARD treatment plant. The treatment process would utilize an optimized precipitation treatment process using proprietary polymer technology to encapsulate metal hydroxides. Chemical reagents would be used to adjust pH during the process prior to addition of polymers. Sedimentation followed by microfiltration membranes would be used to remove the metal precipitates. Sludge residuals are disposed of at an on-stie location (e.g., dewatered, lined ponds). The process train also includes the chemical and polymer feed systems; mix tanks; sedimentation tanks; sludge tanks; and all pumps, instrumentation and appurtenances. Also included are annual O&M operations for the treatment plant including utilities, staff, administration, site snow removal, and weekly monitoring sampling and support.

Treatment Capacity, gpm = 300 gpm

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1	**CAPITAL COSTS**					
1.1	CIVIL/SITEWORK					
1.1.1	Excavation	940	CY	10	10,000	PW - General Note 1
1.1.2	Fine Grading	940	SY	1	1,000	Means Heavy Construction Cost Data (2001), 02305-440-1100
1.1.3	Structural Fill below SOG	313	CY	20	7,000	PW - General Note 1
1.1.4	Aggregate below SOG	313	CY	19	7,000	Means Heavy Construction Cost Data (2001), 02315-505-1100
1.1.5	Disposal (non-contaminated materials)	1	LS	2,000	2,000	Means Heavy Construction Cost Data (2001), 02220-875-5550
				Subtotal	*27,000*	
1.2	STRUCTURAL					
1.2.1	Pre-Fabricated Steel Building	8100	SF	9	73,000	Means Cost Data (2001), 13128-700-1100, x-6900
1.2.2	Concrete, Building and Tank Foundations	313	CY	250	79,000	Means Cost Data (2001), 03310-240-4050
				Subtotal	*152,000*	
1.3	PROCESS/MECHANICAL					
1.3.1	Headworks Pump	1	EA	44,000	44,000	VQ - General Note 1
1.3.2	Optimized Precipitation process train, including:	1	LS	1,469,000	1,469,000	VQ - General Note 1; see Note A below
	pumps					
	chemical storage					
	chemical feed					
	membranes					
	piping					
	accessories					
	filter press					
	electrical and I&C					

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
1.3.3	Settled Water Storage Tank	1	EA	21,500	22,000	VQ - General Note 1
1.3.4	Sludge Conditioning/Handling Equipment					
1.3.4.1	Sludge Storage Tank	1	LS	47,921	48,000	VQ - General Note 1
1.3.4.2	Sludge Transfer Pump to Filter Press	1	EA	16,875	17,000	VQ - General Note 1
1.3.5	Piping					
1.3.5.1	PVC - 1"	0	LF	9	0	Means Heavy Construction Cost Data (2001), 15108-520-4410
1.3.5.2	PVC - 2"	0	LF	11	0	Means Heavy Construction Cost Data (2001), 15108-520-4460
1.3.5.3	PVC - 4"	100	LF	15	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4480
1.3.5.4	PVC - 6"	0	LF	21	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.5	PVC - 8"	40	LF	33	2,000	Means Heavy Construction Cost Data (2001), 15108-520-4500
1.3.5.6	PVC - 12"	0	LF	66	0	Means Heavy Construction Cost Data (2001), 15108-520-4490
1.3.5.7	HDPE - 2"	0	LF	15	0	General Note 9
1.3.5.8	HDPE - 4"	0	LF	23	0	General Note 9
1.3.5.9	HDPE - 8"	600	LF	32	20,000	General Note 9
1.3.5.10	Valves and Appurtenances	1	LS	15,000	15,000	General Note 8
				Subtotal	*1,639,000*	
1.4	ELECTRICAL	1	LS	15,800	16,000	General Note 6
1.5	INSTRUMENTATION and CONTROLS	1	LS	19,700	20,000	General Note 6
	Capital Costs			**Subtotal**	**1,854,000**	
1.6	CONSTRUCTION PRORATES	1	LS	225,000	*225,000*	General Note 10; see Note A below
	General Conditions (Overhead)[a]		20% of Total Cost	77,000		
	Contractor's Profit [b]		10% of Total Cost + GC	47,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	102,000		
1.7	ENGINEERING COSTS	1	LS	396,000	*396,000*	General Note 11; see Note A below
	Remedial Design		8% of Total Cost + Const Prorates	167,000		
	Project Management		5% of Total Cost + Const Prorates	104,000		
	Construction Management		6% of Total Cost + Const Prorates	125,000		
	CAPITAL COSTS			**Total**	**2,475,000**	

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2	ANNUAL COSTS					
2.1	CHEMICALS					
2.1.1	pH Adjustment	1	LS	65,000	65,000	VQ - General Note 1
2.1.2	Chemicals (inc. proprietary)	1	LS	75,000	75,000	VQ - General Note 1
				Subtotal	*140,000*	
2.2	SLUDGE DISPOSAL		see General Note 2			
2.3	MONITORING/SAMPLING					
2.3.1	Compliance Monitoring	1	LS	27,000	*27,000*	General Note 13
2.3.2	Operational Monitoring	1	LS	41,000	*41,000*	General Note 14
				Subtotal	*68,000*	
2.4	STAFF					
2.4.1	Plant Engineer	1	annual salary	82,500	83,000	General Note 4
2.4.2	Operators	8	annual salary	38,100	305,000	General Note 4
2.4.3	Mechanic	2	annual salary	59,800	120,000	General Note 4
2.4.4	Chemist	1	annual salary	39,600	40,000	General Note 4
2.4.5	Security	2	annual salary	34,200	69,000	General Note 4
2.4.6	Administrative Assistant	1	annual salary	25,000	25,000	General Note 4
				Subtotal	*642,000*	
2.5	OTHER DIRECT COSTS					
2.5.1	Project Manager	1040	hours per year	40	42,000	General Note 4
2.5.2	Junior Engineer	240	hours per year	30	8,000	General Note 4
2.5.3	Project Engineer	240	hours per year	50	13,000	General Note 4
				Subtotal	*63,000*	
2.6	INDIRECT COSTS					
2.6.1	Radio and Pager Rental	1	LS	2,000	2,000	General Note 4
2.6.2	Vehicles					
2.6.2.1	Dozer	12	months	4,325	52,000	Means Heavy Construction Cost Data (2001), 01590-200-4150
2.6.2.2	Front Loader	12	months	6,000	72,000	Means Heavy Construction Cost Data (2001), 01590-200-4730
2.6.2.3	Suburban	12	months	900	11,000	Means Heavy Construction Cost Data (2001), 01590-400-7250
2.6.2.4	Pickup Truck	12	months	2,250	27,000	Means Heavy Construction Cost Data (2001), 01590-400-7200
2.6.2.5	Fuel	1	year	138,000	138,000	based on hourly costs for above Items, 8 hrs/365 days
2.6.3	Road Grading	4	per year	5,000	20,000	General Note 4
2.6.4	Temporaty Lab	12	months	350	5,000	Means Heavy Construction Cost Data (2001), 01520-500-0550
2.6.5	Supplies	1	LS	131,800	132,000	General Note 4
2.6.6	Utilities					
2.6.6.1	Water	1	LS	*5,000*	*5,000*	General Note 4
2.6.6.2	Phone	12	months	500	6,000	Means Heavy Construction Cost Data (2001), 01520-550-0140

Item		Quantity	Unit	Unit Bare Cost ($)	Total Bare Cost (nearest $100)	Notes
2.6.6.3	Electrical					
2.6.6.3.1	Pumps					
2.6.6.3.1.1	Ruby Gulch to Sunday Pit	150	HP	429/(HP*yr)	22,000	General Note 5; 8 hours per day average over year
2.6.6.3.1.2	Pond E to (E) WTP	150	HP	429/(HP*yr)	65,000	General Note 5; 24 hours/day, 365 days/year
2.6.6.3.1.3	Heap Leach Recirculating (On-Solution)	150	HP	429/(HP*yr)	38,000	General Note 5; October through April, 24 hours/day
2.6.6.3.1.4	Heap Leach Recirculating (concurrently w/2.5.6.3.1.3)	15	HP	429/(HP*yr)	4,000	General Note 5; October through April, 24 hours/day
2.6.6.3.2	General Process Train	132.5	HP	429/(HP*yr)	57,000	General Note 5
2.6.6.3.3	Sludge Handling Equipment					
2.6.6.3.3.1	Filter Press	5	HP	429/(HP*yr)	3,000	General Note 5
2.6.6.4	Fuel for Pumps/Heaters (diesel and propane)	12	months	10,080	121,000	Based on actual site usage + 20% adjustment for new WTP building
				Subtotal	*780,000*	
	Annual O&M Costs			**Subtotal**	**1,693,000**	
2.7	CONSTRUCTION PRORATES	1	LS	991,000	*991,000*	General Note 10
	General Conditions (Overhead)[a]		20% of Total Cost	339,000		
	Contractor's Profit[b]		10% of Total Cost + GC	204,000		
	Scope and Bid Design Contingency [c]		20% of Total Cost + GC + Profit	448,000		
2.8	ENGINEERING COSTS	1	LS	162,000	*162,000*	General Note 11
	Construction Management		6% of Total Cost + Const Prorates	162,000		
	ANNUAL O&M COSTS			**Total**	**2,846,000**	
				per month	**$237,167**	
				per 1,000 gallons	**$18.05**	

Notes

A Construction Prorates and Engineering Costs are not applied to Item 1.3.2; quoted costs include materials and installation of proprietary process train.